

LOWERING URBAN TRAFFIC SPEEDS TO ACHIEVE
SUSTAINABLE LAND TRANSPORT OUTCOMES IN
NEW ZEALAND

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Abstract

A number of methods are being undertaken in New Zealand to achieve sustainable land transport outcomes. Lower urban speeds (less than 50 km/h) are increasingly being used to improve safety, but may also contribute to other sustainable land transport outcomes. This research includes: a literature review, case studies, a survey of industry professionals and comparative analysis, to consider the potential effectiveness and efficiency of reducing urban speeds¹ to achieve sustainable land transport outcomes.

There is reasonable consistency between the findings of the survey, case studies and literature review. The key areas of difference relate to the survey responses potentially under-estimating political and public support for reducing speeds. The responses also over-estimate the current contribution of industry knowledge, and the adverse effects of travel times, vehicle emissions, and fuel usage.

In respect to efficiency, reducing urban speeds can be successfully implemented in New Zealand, time and cost requirements are achievable, and legislation is permissive, but additional guidance and industry knowledge is required. Political and public opinions are difficult to determine but there is nothing to suggest that there is widespread opposition to reducing urban speeds, particularly in residential, high pedestrian and business areas.

In respect to effectiveness, reducing urban speeds can contribute to improving: safety, public health, accessibility, integrated urban form, environmental sustainability² and economic development. The impact of increased travel times on functional transport networks is likely to result in some adverse effects, but these are not likely to be significant.

Compared to the provision of walking and cycling infrastructure, from the information available, reducing urban speeds is considered to be at least as effective at achieving sustainable land transport outcomes. Reducing urban speeds could also be as efficient, as provision of walking and cycling infrastructure, with more consistent political support, more guidance on the use of legislation, and once the level of industry knowledge improves.

¹ It is not the purpose of this research to consider where or at what scale reduced speeds would be appropriate. Reference to reducing urban speeds is referring to the concept and not to particular types of streets or at a set scale.

² New methods for measuring and modelling vehicle emissions and fuel usage indicate no noticeable overall change from reducing speed limits in urban areas.

1 Introduction

A number of methods (for example, provision of walking and cycling infrastructure) are currently being undertaken in New Zealand to achieve sustainable land transport outcomes (safety, accessibility, environmental sustainability, public health, functional transport networks, economic development and integrated urban form).

Lower urban speeds (less than 50 km/h)³ are increasingly being used to achieve safety benefits in urban areas. Lower urban speeds may also have wider impacts that could contribute to sustainable land transport outcomes. This thesis seeks to consider the effectiveness and efficiency of reducing urban speeds to achieve sustainable land transport outcomes.

1.1 Background

Across central, regional and local levels of government, in New Zealand, there has been an increasing focus on sustainable land transport outcomes (Environment Canterbury, 2008). This has resulted in central, regional, and local strategies and plans, to achieve outcomes (Dunbar et al., 2010) such as:

- More live-able communities (e.g. improve quality of built environments);
- Reduced use of non-renewable resources (e.g. fossil fuels);
- Reduced impact on life-supporting resources (e.g. reduced green-house gas emissions and contamination of soil and water);
- Healthy cities (e.g. improved urban amenity);
- Improved safety (e.g. reduced road casualties);
- Increased accessibility of economic and social centres.

A number of methods or actions are identified at different levels to achieve the sustainable land transport outcomes (Environment Canterbury, 2008). Commonly these methods focus on (Ministry of Transport, 2008a; Ministry of Economic Development, 2011):

³ It is not the purpose of this research to consider where or at what scale reduced speeds would be appropriate. Reference to reducing urban speeds is referring to the concept and not to particular types of streets or at a set scale.

- Requirements for integrated land transport planning;
- New land use and transport rules and legislation (e.g. vehicle emissions standards, land use density requirements);
- Improved public transport and provision for active modes (walking / cycling);
- Carpooling / high occupancy vehicle lanes;
- Flexible work hours;
- Road safety advertising; and,
- Travel Plans.

Reducing urban speeds has not typically been considered as method to achieve these sustainable land transport outcomes. Lower urban speeds (less than 50 km/h) have however been used in specific locations in cities within New Zealand. The primary justification for these has been safety, particularly where shared zones are created (O’Fallon and Sullivan, 2011).

1.2 Scientific Problem

Although there has been increased recognition that lower urban speeds may have wider benefits than improving safety, there is little acknowledgement of the potential for reduced urban speeds to contribute to sustainable land transport outcomes.

The current approaches to achieving sustainable land transport outcomes in New Zealand are focused on development of transport strategies. Implementation methods primarily focus on: provision of walking, cycling and public transport infrastructure / services, road safety improvements, and education, advertising or awareness campaigns.

Some strategies are identifying localised use of reducing urban speeds but solely from a safety perspective. The scientific problem being investigated is whether reducing urban speeds can contribute to wider sustainable land transport outcomes in a comparably efficient and effective way to the methods currently being implemented to achieve these outcomes.

1.3 Research Motivations

The primary motivation for this research is to build on research by others, into the wider benefits, of the use of reduced urban speeds to achieve wider sustainable land transport outcomes.

The safety benefits of reducing urban speeds are becoming increasingly recognised and there is a growing body of literature available on the impacts of reducing urban speeds on aspects such as mode-shift, vehicle emissions, travel time, noise and amenity. There however appears to be limited exposure and knowledge of these impacts amongst industry professionals in New Zealand. Consequently reduced urban speeds are not currently being considered as a method to achieve a variety of sustainable land transport outcomes sought by local and regional Councils.

It is therefore important to consider the comparative efficiency and effectiveness, of reducing urban speeds, with methods that are currently being employed. It is hoped that this research will provide a resource for the industry in respect to the potential future use of lower urban speeds to achieve sustainable land transport outcomes in New Zealand.

1.4 Research Objectives

The aim of this research is to determine whether reducing urban speeds could achieve the sustainable land transport outcomes sought, in New Zealand, in a more effective and efficient way than current methods being undertaken to achieve these outcomes.

In order to achieve this aim there are four key objectives for this research:

- To identify the key sustainable land transport outcomes sought within New Zealand and the methods being undertaken to achieve them;
- To consider the likely contribution of reduced urban speeds towards achieving sustainable land transport outcomes;
- To consider industry and public perception of reducing urban speeds; and,
- To compare the effectiveness and efficiency of reducing urban speeds to achieve sustainable land transport outcomes, relative to current methods being undertaken.

1.5 Hypothesis

From initial investigations into this topic it is hypothesised that reducing urban speeds could contribute to a variety of sustainable land transport outcomes. It is likely that lower speeds would contribute to some outcomes more than others, but overall would be comparably effective and efficient at achieving sustainable land transport outcomes when considered against other methods commonly used.

1.6 Thesis Structure

This thesis is organised into 8 sections. Sections 2 and 3 set out the findings of the literature review on sustainable land transport in New Zealand and the effects of reducing urban speeds.

Section 4 considers the efficiency and effectiveness of reducing urban speeds in three case studies: Graz, Austria, Unley, Australia and Hamilton, New Zealand. Section 5 sets out the New Zealand industry professionals survey and results. Section 6 draws together findings from sections 2-5, as a discussion, on the potential effectiveness and efficiency of reducing urban speeds to achieve sustainable land transport outcomes in New Zealand.

Section 7 provides a comparative analysis of reducing urban speeds with providing walking and cycling infrastructure to achieve sustainable land transport outcomes.

Finally, section 8 details the conclusions, recommendations and areas for further research.

2 Literature Review Part 1: Sustainable Land Transport

In order to identify the effects of reducing urban speeds on sustainable land transport it is first necessary to understand what is meant by sustainable land transport in New Zealand. This section therefore provides a summary of the relevant literature on sustainable land transport, including defining sustainable land transport's importance. This section also includes consideration of current strategies and methods to achieve sustainable land transport in New Zealand.

2.1 *Defining sustainable land transport*

There is no conclusive or widely applied definition of sustainable land transport. The “Resource Management Act 1991” (RMA) (Ministry for the Environment, 1991) sets out that the purpose of the act is to promote the sustainable management of natural and physical resources. Sustainable management is defined in Part 2, Section 5 of the RMA as: *“managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while:*

- (a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
- (b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
- (c) avoiding, remedying, or mitigating any adverse effects of activities on the environment”*

Similarly, the “Economic Evaluation Manual (Volume 1)” (New Zealand Transport Agency, 2010), defines sustainability as *“development that meets the needs of the present without compromising the ability of future generations to meet their own needs”*.

Sustainable land transport is one of a number of aspects that contribute to sustainable management of natural and physical resources. For example, the “Land Transport Management Act 2003” (Ministry of Transport, 2008b) outlines the purpose of the Act (in Section 3) as: *“to contribute to the aim of achieving an affordable, integrated, safe, responsive and sustainable land transport system”*. The Act is considered to contribute to that purpose by:

- *Providing an integrated approach to land transport funding and management; and*
- *Improving social and environmental responsibility in land transport funding, planning, and management; and*
- *Providing the Agency with a broad land transport focus; and*
- *Improving long-term planning and investment in land transport, including planning and investment in coastal shipping and rail; and*
- *Ensuring that land transport funding is allocated in an efficient and effective manner; and*
- *Improving the flexibility of land transport funding by providing for alternative funding mechanisms.*

The “New Zealand Transport Strategy 2008” (Ministry of Transport, 2008a), states that a sustainable transport system needs to contribute to achieving New Zealand’s economic, social, environmental and cultural goals for the benefit of current and future generations.

In terms of a practical approach, Tonkin and Taylor Limited (2008) identified seven ‘building blocks’ that they considered collectively encapsulated sustainable land transport. These building blocks are: safety, accessibility, environmental sustainability, public health, functional transport networks, economic development and integrated urban form. These are briefly described below.

- Safety considers the significant impact that land transport networks can have on the safety of people and communities (Tonkin and Taylor Limited, 2008).
- Accessibility relates to how well transport networks meet the needs of people to move themselves and goods throughout the transport network, for example, meeting people’s transport needs between home, work and recreation. The variety of transport modes available to undertake travel is also a key consideration. This includes whether access to a site is available not only by private motor vehicle, but also bicycle, public transport and on foot (Tonkin and Taylor Limited, 2008).
- Environmental sustainability includes consideration of the impact of land transport, on both the natural and social environment. In respect to the natural environment,

land transport can adversely affect aspects such as: air and water quality, ecological habitats, natural hazards, and climate change. Adverse effects on the social environment include aspects such as community cohesion, cultural and historical resources, amenity values and consumption of land resources (Tonkin and Taylor Limited, 2008).

- Public health with respect to sustainable land transport encapsulates transport networks that facilitate improved public health through avoiding discharges to air which are harmful to people, encouraging uptake of active modes and therefore greater levels of exercise, as well as the impact of transport on land use activities which may be noise or vibration sensitive (Tonkin and Taylor Limited, 2008).
- Functional transport networks consider the ability of transport networks to serve their intended purpose, for example, the ability of local roads to provide for property access or collector roads to distribute vehicles onto the wider road network (Tonkin and Taylor Limited, 2008).
- Economic development in respect to sustainable land transport recognises the economic impacts that transport systems can have on businesses (Tonkin and Taylor Limited, 2008). A common example is consideration of efficient freight routes, but there are also other impacts, for example, pedestrian volumes can also affect retail sales (Litman, 2004).
- Integrated urban form recognises the impacts of land transport networks and land use on each other. Land uses provide the destinations between which people are seeking to travel, and influence the distance between destinations. The transport network can determine which destinations are available. Changing land uses can therefore change the number, distance and type of trips undertaken. Conversely changing the transport network can change the locations between which people travel (Tonkin and Taylor Limited, 2008).

For the purposes of considering the impact of reducing urban speeds on sustainable land transport, the building blocks approach, to defining sustainable land transport, has been adopted. This approach enables the effects of reducing speeds on each aspect of sustainable

land transport to be considered as component parts and therefore whether more sustainable land transport may eventuate.

2.2 Why is sustainable land transport important

Encouraging sustainable land transport is increasingly being considered as part of the solution to wider environmental problems such as biodiversity loss, accelerated global warming, air and water pollution (Craig, 2004). Many of these problems are inter-related.

Urban sprawl is increasing the need and distance to travel for work, education and to access goods and services. The increasing need to travel increases congestion and journey times. Reducing the need to travel requires better integration of landuse and transport. In New Zealand urban areas, maintaining efficient transport systems will also be important for assisting long term economic growth (Ministry of Transport, 2008a).

Transport safety had been improving in New Zealand, however more recently this has plateaued. Increasing motor vehicle travel has the potential to worsen safety trends, impacting on public health (Ministry of Transport, 2008a).

A more sustainable approach to transport not only seeks to reduce travel demand but also manage the way people travel, for example, changing short vehicle trips to walking or cycling. This recognises that conventional sources of energy (oil) are finite and demand is growing both in New Zealand and globally; eventually demand will almost certainly exceed supply. This will lead to increasing fuel costs, which, if alternatives are not found, could have a negative impact on mobility and the New Zealand economy (Ministry of Transport, 2008a).

Greenhouse gas emissions from transport are responsible for a significant and increasing proportion of New Zealand's total emissions (currently around one fifth) (Ministry of Transport, 2008a).

Walking and cycling produces very little greenhouse gas emissions and generates net public health benefits. In New Zealand the proportion of people walking and cycling to work has been decreasing. Public transport is generally a more energy efficient means of transport than light passenger vehicles. Public transport use in New Zealand has been increasing slowly (Statistics New Zealand, 2009).

Older people, children and lower socio-economic groups are often unable to drive themselves and rely upon a diverse transport system, including public transport and provision for active modes, to enable them to meet their mobility and access needs (Ministry of Transport, 2008a).

From the examples above, it is clear that, moving towards sustainable land transport is important for the future social, cultural, environmental and economic well-being of New Zealanders.

2.3 Sustainable land transport in New Zealand

Moves towards more sustainable land transport in New Zealand include overarching guidance at central government level and targeted strategies at regional and local government levels. There are a number of relevant central government strategies and policies, that guide the direction of sustainable land transport in New Zealand. A brief summary of these is provided below in order to identify the direction for sustainable land transport in New Zealand.

Regional and local councils are also including outcomes related to sustainable land transport in their strategies and plans. Consideration is given to the relevant outcomes and methods to achieve them, in strategic documents relating to Wellington and Hamilton, to provide an insight into sustainable land transport at Council level.

2.3.1 Sustainable land transport at central government level

The key central government strategies to guide sustainable land transport in New Zealand relate to: walking and cycling, road safety, energy use, infrastructure plans and government policy statements.

“Getting there – on foot, by cycle, a strategy to advance walking and cycling in New Zealand Transport” (Ministry of Transport, 2005) sets out a vision that people from all sectors of the community walk and cycle for transport. The priorities for action seek to achieve this in an integrated way. Examples include encouraging land use planning and design, which supports walking and cycling, improving attitudes towards walking and cycling, and improving safety. The strategy relates the benefits of walking and cycling, to some of the following building blocks of sustainable land transport, for example:

- **Accessibility:** walking is the second most common travel mode (19% of household trips), walking and cycling are important for those with less travel options (e.g. children) and supports other modes of transport (e.g. walking to a bus stop). Therefore improvements for walking and cycling, contribute to more connected and liveable communities.
- **Public health:** promoting walking and cycling as transport will contribute to increased physical activity and a healthier population.
- **Environmental sustainability:** walking and cycling are considered the most environmentally friendly forms of transport as they are non-polluting and use almost no fossil fuels.
- **Economic development:** pedestrians and cyclists can provide benefits to local economies; people who walk and cycle more often are more likely to shop locally. Pleasant walking environments in town centres can attract customers (foot traffic is the life blood of many small businesses).
- **Safety:** improved walking and cycling environments reduce road fatalities among pedestrians and cyclists.

The strategy does not directly link walking and cycling to the functional transport or integrated urban form building blocks however there is direct recognition of the need for integrated planning and consideration of the impact of landuse throughout the strategy.

“New Zealand Transport Strategy 2008” (Ministry of Transport, 2008a) sets out a vision for transport in 2040 that people and freight in New Zealand have access to an affordable, integrated, safe, responsive and sustainable transport system.

The vision is supported by five objectives: ensuring environmental sustainability, assisting economic development, assisting safety and personal security, improving access and mobility, and protecting and promoting public health. To achieve these objectives a number of targets have been set for each objective. Some of these targets included specific and measurable goals, such as, to reduce road deaths to no more than 200 per annum, by 2040 (Ministry of Transport, 2008a).

The strategy identifies a number of key components necessary to achieve the vision and targets including: integrated planning, making best use of existing networks and infrastructure, investing in critical infrastructure, increasing the availability and use of public transport, cycling, walking and other shared modes, options for charging to generate revenue for transport infrastructure and services, using new technologies and fuels, and maintaining and improving international links (Ministry of Transport, 2008a).

Overall the New Zealand Transport Strategy has no direct recognition of the need for integration of urban form in its objectives, despite this the strategy generally covers all the key building blocks of sustainable land transport well and reasonably evenly.

“Safer Journeys: New Zealand’s Road Safety Strategy 2010-2020” (Ministry of Transport, 2010) was released in March 2010. The Road Safety Committee’ has also released the “Safer Journeys Action Plan 2011-2012” (National Road Safety Committee, 2010). These seek a safe system approach to road safety and the objectives are: to make the road transport system more accommodating of human error, manage the forces in a crash to a level which can be tolerated by the human body (without serious injury), and minimise the level of unsafe road user behaviour. The approach views the road transport system holistically, considering the relationship between four key aspects: the road user, road (including road sides), speed, and the vehicle. The action plan sets out a range of actions for 2011-12 to contribute to the safe systems approach and particularly focuses on embedding the safe systems approach in New Zealand, and increasing the public’s awareness and understanding about the approach to road safety (National Road Safety Committee, 2010).

In terms of safe speeds the focus includes campaigns to help people understand why and how to manage their speed safely, creating speed limits that reflect the standard of the road network (including focus on pedestrian and cyclist safety), and increased use of cameras to reduce mean speeds and free up police resources. Progress towards the identified actions is to be monitored by the National Road Safety Management Group and the National Road Safety Committee with a consolidated report to be published annually (National Road Safety Committee, 2010).

Whilst the safety strategy is focused primarily on the safety building block this also has some implications for public health, economic development (cost of accidents) and contributes to functional transport networks.

The “New Zealand Energy Strategy 2011-2021 and New Zealand Energy Efficiency and Conservation Strategy 2011-2016” (Ministry of Economic Development, 2011) identifies some transport related areas to focus on including: developing renewable energy resources, reducing greenhouse gas emissions, and an energy efficient transport system. It identifies that in 2009, around 44% of energy related greenhouse gas emissions were from transport. The transport related objective seeks a more energy efficient transport system, with a greater diversity of fuels and alternative energy technologies (Ministry of Economic Development, 2011).

Policy discussions set out that this will require an integrated mix of measures including quality roads and public transport services, ensuring the integration of modes in urban planning, and vehicle fuel economy labelling (Ministry of Economic Development, 2011).

The energy strategies relate to: functional transport networks (efficient transport minimises energy use), economic development (economy is reliant on energy for transport), integrated urban form (to reduce energy use), and environmental sustainability (move towards renewable energy).

“Connecting New Zealand” (Ministry of Transport, 2011a) was released in 2011 to summarise the government’s broad policy direction for transport over the coming decade. To an extent “Connecting New Zealand” also supersedes many of previous strategies and provides direction on the government’s current priorities.

“Connecting New Zealand” (Ministry of Transport, 2011a) has an overall objective that transport is an effective, efficient, safe, secure, accessible and resilient transport system that supports the growth of the country’s economy, in order to deliver greater prosperity, security and opportunities for all New Zealanders.

Key government actions include: investment in road infrastructure (particularly state highways and roads of national significance), continued reduction of emissions of carbon dioxide from land transport, implementing a safe systems approach, and improving rail /

public transport efficiency and operation (Ministry of Transport, 2011a). These actions represent an increased focus on economic factors compared to the above strategies produced under the former government, which had a stronger focus on environmental sustainability. This change in focus most likely reflects both the different government policies and also recent changes to the global economy.

“The National Infrastructure Plan 2011” (Ministry for Infrastructure, 2011) sets a vision that by 2030 New Zealand’s infrastructure is resilient and coordinated, and contributes to economic growth and increased quality of life. The National Infrastructure Plan specifically considers transport (in Part 2) and seeks that the transport sector supports economic growth by achieving efficient and safe movement of freight and people (Ministry for Infrastructure, 2011).

Although the overall focus is on economic development, value for money and safety, the goals for transport are slightly wider ranging including: a long-term strategic approach to transport planning, a flexible and resilient transport system that offers greater accessibility and can respond to changing demand, and a public transport system that is robust and effective and will attract a greater percentage of long term users. On this basis, the National Infrastructure Plan 2011 still covers around half of the sustainable land transport building blocks (safety, accessibility, functional transport networks, and economic development), to some degree.

The “Government Policy Statement on Land Transport Funding 2012/13-2021/22” (Ministry for Transport, 2012) sets out what the government is expecting to achieve from investment in land transport, how it will be achieved, how much funding will be provided, and how the funds will be raised. It generally reflects the strategic direction set out in “Connecting New Zealand”, the “National Infrastructure Plan” and “Safer Journeys Road Safety Strategy” (Ministry for Transport, 2012).

Overall, the strategic direction for land transport in New Zealand generally covers all of the building blocks of sustainable land transport. Recently however the relative priorities have moved towards economic development, functional transport networks and safety.

2.3.2 Sustainable land transport at council level

Local and regional councils are required to sustainably manage natural and physical resources, for example, under sections 30 and 31 of the Resource Management Act (Ministry for the Environment, 1991).

In order to identify sustainable land transport outcomes / objectives sought, in New Zealand, by local and regional councils, a review of all relevant sustainable land transport strategy / policy documents was undertaken for Wellington and Hamilton. These two cities were selected as they represented different sized cities that both had recently (generally over the last five years) developed or revised relevant strategies and policies.

The relevant strategies and policies, for each city, were reviewed and the key outcomes identified⁴. Consideration was then given to the focus of these outcomes in terms of which of the key sustainable land transport building blocks they related to. A full list of the strategies reviewed, and the outcomes identified, is provided in Appendix 1. This provides an insight into the current focus on different aspects of sustainable land transport amongst local and regional councils.

Figure 1 shows the relative proportion of outcomes related to each building block.

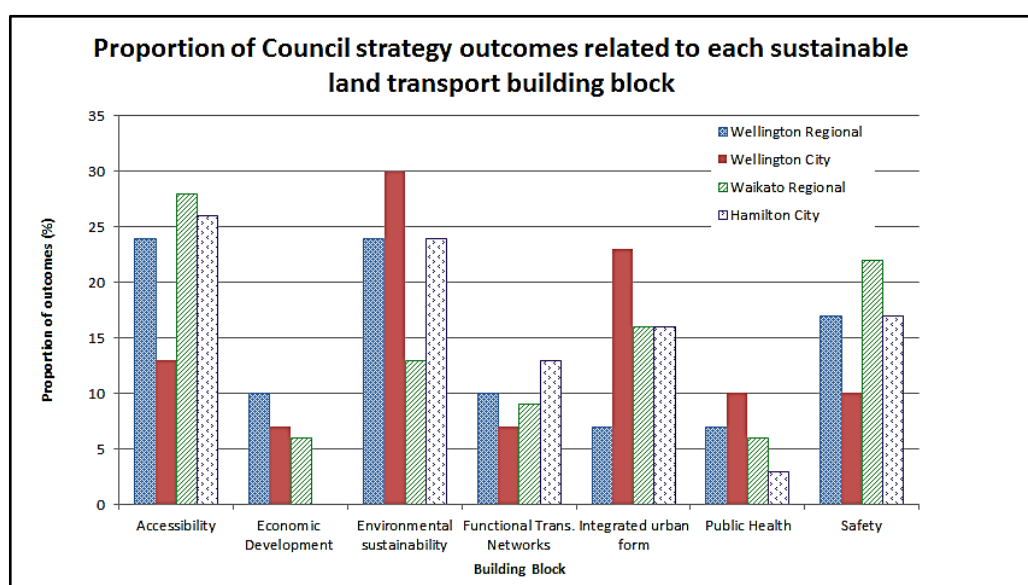


Figure 1: Proportion of strategy outcomes related to each building block

⁴ This generally relied upon objectives, where no objectives were stated this was otherwise derived from anticipated results.

Figure 1 shows that Council land transport related strategies and policies, in both Wellington and Hamilton, generally include outcomes related to each building block. The relative proportion of outcomes related to each building block, provides an indication as to the relative focus on these different components of sustainable land transport.

The greatest proportion of outcomes (in the strategies and policies reviewed) related to environmental sustainability, and accessibility, followed by integrated urban form, and safety. Whilst a lesser proportion of outcomes related to public health, and economic development, this may reflect the less direct relationship between transport and these aspects. The lower proportion of outcomes related to functional transport networks is surprising, but may reflect a lesser need to focus on this at the strategic level given many infrastructure improvements / replacements are undertaken on a routine basis.

The greater overall focus on environmental sustainability, accessibility, and integrated urban form, differs from the key priorities of the most recent central level transport strategies. This may reflect a lag between changes in government policy direction and revision of local government strategies, and / or may reflect a greater effort to maintain a wider strategic focus for sustainable land transport at local government level (despite central government level funding cuts in some of these areas).

In terms of differences between the strategies and policies of the four Councils, the relative focus on the different building blocks was reasonably consistent. The only notable differences were:

- The greater focus on environmental sustainability than accessibility in Wellington City Council strategies and the reverse for Waikato Regional Council strategies.
- A much greater focus on outcomes related to integrated urban form and lesser focus on outcomes related to safety within Wellington City Council strategies.
- No outcomes relating to economic development in the Hamilton City Council strategies reviewed.

The review of the sustainable transport related strategies and policies for Wellington and Hamilton also considered what methods are currently being employed to achieve these outcomes. Figure 2 shows the percentage of documents reviewed that included similar

methods. A table showing the documents reviewed and the methods identified, in each document, is attached as Appendix 2.

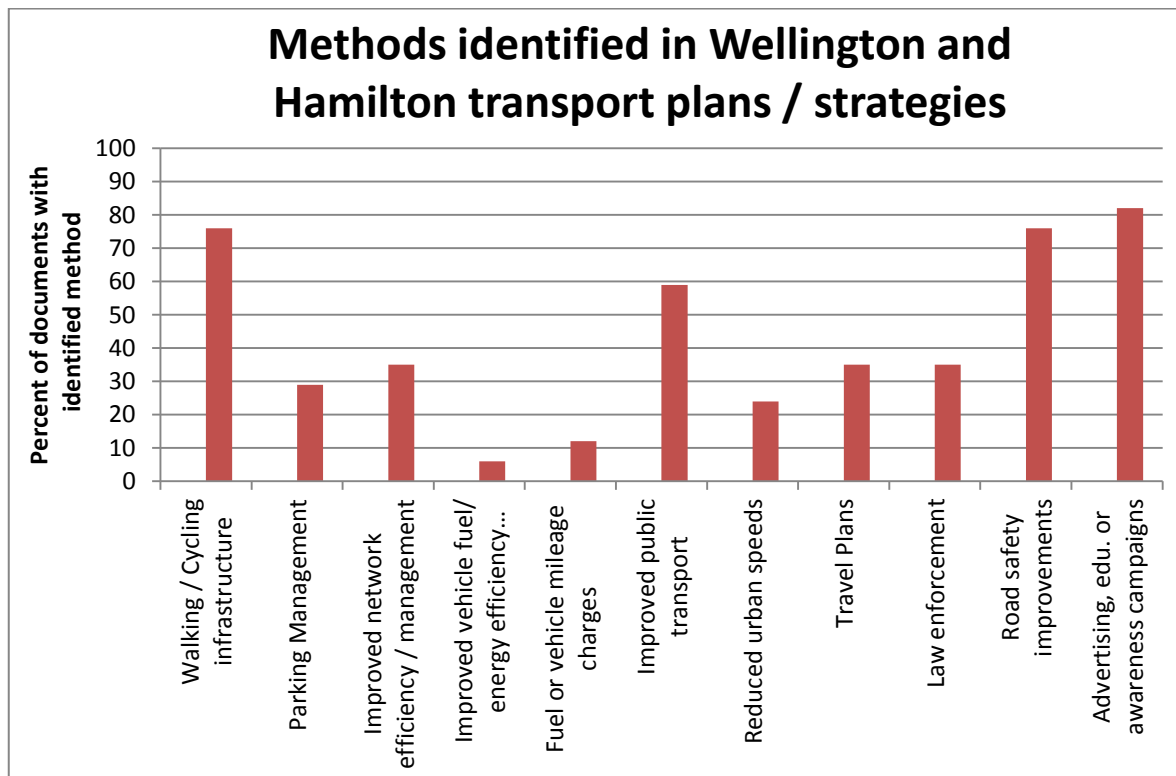


Figure 2: Methods being used to achieve transport strategy outcomes

Figure 2 indicates that the most commonly adopted methods related to: walking and cycling infrastructure (76% of strategies and policies), road safety improvements (76% of strategies and policies), and advertising, education or awareness campaigns (82% of strategies and policies).

A small proportion (24%) of the documents reviewed identified reducing urban speeds as a method. These methods were identified solely in respect to achieving safety-related outcomes. There was no use of reducing urban speeds to achieve any of the other sustainable land transport building block outcomes.

2.4 Summary

From the discussion above, it is clear that considering sustainable land transport is important, particularly in the context of transport's contribution to local and global problems such as: climate change, depleting stocks of fossil fuels, and increasing air pollution.

Whilst there is not one clear definition of sustainable land transport, the building block approach, advocated by Tonkin and Taylor Limited (2008), provides a robust yet digestible way to consider sustainable land transport. These building blocks are: safety, functional transport networks, economic development, public health, integrated urban form, environmental sustainability and accessibility.

Consideration of central government strategies against each of these building blocks, shows that whilst all of the building blocks are included within one or more relevant strategies, the most recent strategies are placing a greater priority on economic development, functional transport networks and safety. This most likely reflects the change in government and the global economy. These factors have affected transport budgets and resulted in a greater focus on immediate, rather than longer term, goals for transport.

Regardless, at Council level, the Wellington and Hamilton strategies and policies reviewed suggest that council strategies and policies related to sustainable land transport may have a wider focus. The outcomes identified in these strategies indicated a reasonable focus on accessibility, environmental sustainability, and integrated urban form. This could reflect a lag between revision of central government and council strategies or commitment at council level to a wider strategic approach to sustainable land transport (despite current funding restrictions).

Finally, the review of Wellington and Hamilton strategies also enabled consideration of what methods are being adopted to achieve sustainable land transport outcomes. This indicated that walking and cycling infrastructure, advertising education or awareness campaigns, road safety improvements, and public transport were the most common methods identified to achieve sustainable land transport outcomes. Reducing urban speeds was identified in only approximately 24% of the strategies and policies reviewed and was considered solely as a method to achieve safety-related outcomes.

3 Literature Review Part 2: Urban Speeds

This section reviews the available literature on reducing urban speeds and particularly how this could contribute to sustainable land transport.

Significant improvements in roads and motor vehicles, over recent decades, have enabled people to travel at higher speeds. This has had a number of perceived and actual benefits (for example, reducing travel time, facilitating greater access to employment, goods, and services) that have contributed to improvements in the general quality of life. These higher speeds also however have consequences, particularly in terms of accidents, but also in terms of environmental factors such as noise, livability, and vehicle emissions (OECD, 2006). The need to balance the advantages of higher speeds with the consequences forms the basis of speed management.

Most cities in developed countries have a general 50-60 km/h speed limit in urban areas. More recently some countries have introduced lower speed limits in all or parts of their urban areas. Table 1 below shows some examples of the range of speed limits applied in different countries.

Table 1: Examples of the variation in urban speed limits of developed countries (Austroads, 2008a)

Country	Urban Arterial roads (km/h)	Urban Local and collector roads (km/h)
Canada	50-60	40-50
Finland	50	30-50
France	50	30-50
Greece	50-90	40-50 Collector, 30 Local
Mexico	80	20-60
Norway	50	30-50
Sweden	50-70	30-50
United Kingdom	48-64 (30-40 mph)	32-48 (20-30mph)
United States (varies by State)	48-88 (30-55 mph)	40 -56 (25-35mph)

Adoption of lower speed limits reflects the need to balance the benefits of greater speeds but also the effects of speed in urban areas, where many activities have to co-exist (Dekoster & Schollaert, 1999).

The Ministry of Transport annually surveys free travel speeds (i.e., speed that is uninhibited by other vehicles) of vehicles in New Zealand. The surveys sites are spread around New Zealand, are randomly selected, and have been monitored at the same time of day, and day of the week, since 1995. In 2011 this included 16,188 cars, at 64 urban sites. Annual changes in urban free travel speeds are shown in Figure 3 below (Ministry of Transport, 2011b).

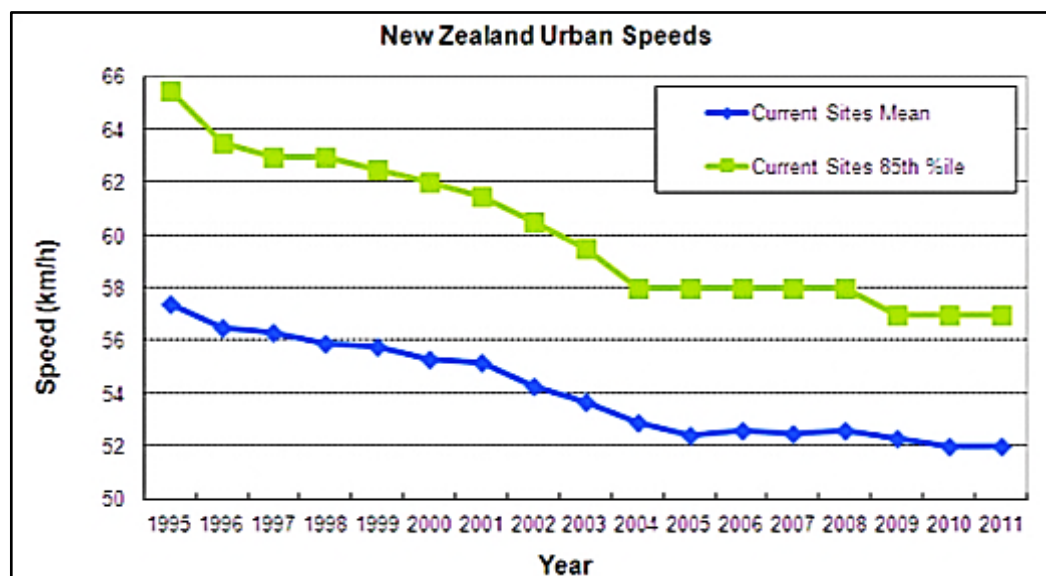


Figure 3: Changes in urban speeds in New Zealand (Ministry of Transport, 2011b)

The general trend in New Zealand is towards decreasing urban speeds. It is likely that this trend reflects a number of factors, including drivers' responses to road safety campaigns, congestion, and enforcement.

This section considers why and how urban speeds can be reduced (below 50 km/h) and the costs and benefits of reducing urban speeds in the context of sustainable land transport.

3.1 Reasons for reducing urban speeds

The safety benefits accruing from reducing urban speeds are commonly identified in sustainable land transport strategies and action plans. Reducing urban speeds can however

also contribute to other sustainable land transport outcomes (OECD, 2006; Department for Transport, 2012).

In urban areas, residents are increasingly seeking lower speeds, to improve environmental quality, improve amenity, provide greater protection for those living near roads, and ensure the safety of pedestrians, cyclists, children, and people with reduced mobility. As a result, reducing urban speeds is being given increasing priority in many countries (OECD, 2006).

It is doubtful that drivers' choice of travel speed represents a good balance between potential advantages and disadvantages. This is because they may not be aware of or consider all the relevant costs and benefits. Some of these do not necessarily accrue directly to the driver but have consequences on others. These include benefits such as reduced actual or perceived travel time, competition or enjoyment and costs such as environmental impacts, loss of amenity, injury to self or others, and costs of crashes (insurance, medical, police) (Austroads, 2008a).

Unfortunately one of the reasons drivers choose to speed is that their personal experiences do not typically lead to a good understanding of the relationship between speed and risk. This is because the majority of individuals will not experience a serious crash when speeding. Most experiences therefore convince drivers that their speeds are safe (i.e., they drove faster but did not crash). Furthermore even those drivers who experience a crash are unlikely to work out how the outcome might have been different if their speed was slightly lower. Even when presented with objective data on speed risk, many people find this surprising and counter-intuitive. This means that not only do drivers speed choices not reflect a good balance between costs and benefits for the community as a whole, but they do not represent a good choice for the individual (Austroads, 2008a).

Reducing speeds can therefore be considered from the perspective of persuading drivers to forego some of the perceived benefits of higher speeds to them, in order to reduce some of the less well perceived risks to them and others (Austroads, 2008a). This however raises the question of how best to encourage drivers to travel slower and whether this will contribute to wider sustainable land transport benefits for the community.

3.2 Efficiency of reducing urban speeds

Whether reducing urban speeds will be an efficient method to achieve sustainable land transport outcomes requires consideration of factors known to affect implementation of sustainable land transport methods. In New Zealand these factors include: the likely success of methods available to achieve reduced speeds, the time and cost of implementation, legislation, public and political opinions as well as the available literature or industry knowledge. These factors are discussed below.

3.2.1 Methods for reducing urban speeds

Managing drivers' speed choice is a complex matter. Drivers' choice of speed is influenced by visual cues of the level of road user activity (congestion, level of pedestrian activity etc.) and physical layout of the road (Austroads, 2008a). Legal methods, predominantly posted speed limits and enforcement also impact on driver speed choice. There is a reasonable body of research into ways to reduce urban speeds. Given the focus of this thesis is not on how urban speeds should be reduced, the discussion below provides only a brief summary of methods to reduce urban speeds. It is intended that this provide sufficient information to inform discussions regarding the efficiency of using reduced urban speeds to achieve sustainable land transport outcomes.

The discussion below considers the use of legal methods, physical measures, and visual cues, as methods to reduce urban speeds. Whilst these are discussed separately below, in many instances these methods are implemented in combination.

It is noted that use of education or awareness campaigns alone has not been considered, as there are few examples of this method and the effects are difficult to ascertain. The use of in-vehicle speed limiting devices has also not been considered, as these are unlikely to be a viable option in New Zealand in the foreseeable future.

3.2.1.1 Legal methods

Speed limits and enforcement are the most commonly used legal methods to manage speed. Reducing speed limits in combination with enforcement and education can reduce the speed and crash risk (Austroads, 2008a). The available literature on the success (or otherwise) of using speed limits in isolation, to reduce urban speeds below 50 km/h, is limited. There

appears to be reasonable acceptance, however, that using solely speed limits leads to only small reductions in traffic speeds (Department for Transport, 2012).

Some research into the effectiveness of speed limits to reduce speeds was undertaken in England (to inform potential legislative changes allowing authorities to replace 30 mph (38.2 km/h) limits with 20 mph (32 km/h) limits without the expense associated with engineering measures required). The research found that use of speed limits (static signs), on average, resulted in a reduction of mean speeds by 2.2 mph (3.5 km/h) and 85th percentile speeds by around 3.2 mph (5.1 km/h). For 20 mph zones they only resulted in an average reduction of 1 mph (Mackie, 1998).

The research also found that speed camera enforcement reduced mean and 85th percentile speeds by around 5 mph (8 km/h) on average, but that effects were localised. Where speed limits were accompanied by education and awareness campaigns and / or enforcement, further speed reductions of 3 mph (4.8 km/h) were achieved (above that achieved from signs only). However even then speeds are likely to remain well above 20 mph (32 km/h) (Mackie, 1998). The Department for Transport (2012) has therefore stated that this approach is appropriate for 20 mph zones only where vehicle speeds are already low (around 24 mph / 38 km/h), in which case signage alone can achieve compliance with the new speed limit (Department for Transport, 2012).

Speed enforcement helps to mitigate differences between speed limits and driver speed choice. Ideally tolerance levels for enforcement should be as low as possible (e.g. 5%), only allowing for inaccuracies in speedometers and measurement devices (OECD, 2006).

Drivers typically reduce their speed when they observe enforcement occurring, however, some “halo effects”, in time and place, have also been recorded. Halo effects arise because drivers perceive that enforcement is more likely (in certain locations, days or times) and thus reduce their speed (Archer et al., 2008). On this basis, an “anywhere, anytime” enforcement programme is likely to have the greatest overall effect on speeds, particularly if the enforcement is widely publicised (OECD, 2006).

The use of speed limits and enforcement in combination with physical measures and visual cues is considered further in section 3.2.1.4 below.

3.2.1.2 Physical measures

Physical devices require drivers to reduce their speed, in order to safely negotiate the device. Physical measures can include: textured pavement, speed tables or humps, mini roundabouts, curb extensions, gateways, and road narrowing's (i.e., traffic calming techniques) (O'Fallon & Sullivan, 2011). The purpose of such devices is to reduce the speed profile of vehicles along the street.

It is not proposed to provide a detailed discussion on the different types of physical methods, as comprehensive guidance on this is available, in a number of guides (for example, Austroads, 2008b). Table 2 however provides a list of some commonly used physical measures, and other ancillary benefits of these devices (Austroads, 2008b).

Table 2: Effects of physical speed reduction devices (Austroads, 2008b)

Measure	Reduce traffic volume	Reduce crash risk	Increase pedestrian safety	Increase cyclists safety
Wombat crossings, Modified T-intersections, Giveaway / stop signs	√	√	√	√
Threshold treatments, Road cushions / flat top humps, Raised pavements	√	√	-	√
School zones, Midblock median treatments	-	√	√	√
Driveway links, Shared zones	√	-	√	√
Road humps, Roundabouts	√	√	-	-
Centre islands	√	-	√	-
Slow points	√	-	-	-
Lane narrowings / kerb extensions	-	-	√	-
Tactile surface treatments	-	-	-	-

Speed reduction is typically achieved by appropriately spacing physical measures such that the average speed, across the street length, is reduced. The change in vehicle speeds at and between devices is illustrated in Figure 4 below (Austroads, 2008b).

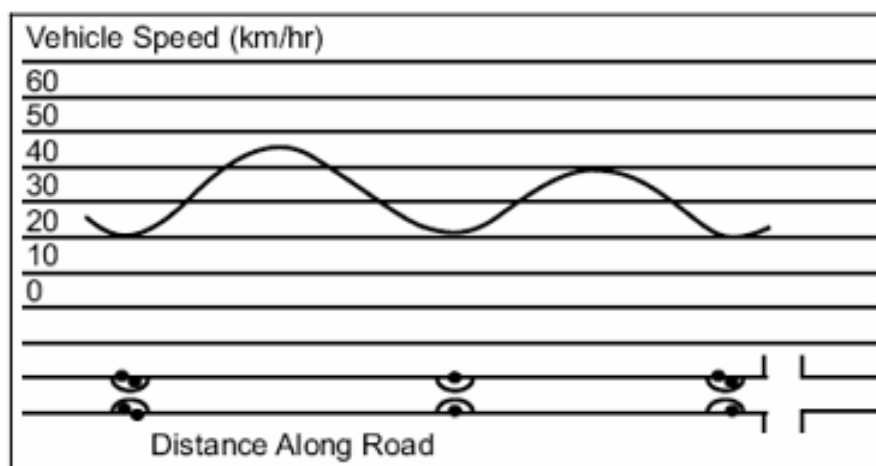


Figure 4: Changes in speed between physical speed control devices (Austroads, 2008b)

Figure 4 indicates how speeds reduce at the device and then increase between the devices. Where greater spacing is provided a constant speed may occur, for some of the distance, between the devices. Appropriate spacing aims to reduce the variability between the speed at and between the devices reducing the maximum and average speed (generally to less than 50 km/h).

Table 3 summarises approximate spacing of devices required to achieve different 85th percentile operating speeds (assuming the devices used reduce speeds to approximately 20 km/h).

Table 3: Spacing of physical speed control devices and 85th percentile speeds (Austroads, 2008b)

Distance between slow points (m)	Max. 85 th percentile speed between slow points
40	25
75	30
100	35
120	40
140	45
155	50

Achieving an 85th percentile speed of 30 or 40 km/h would necessitate installation of physical devices at between 75 and 120 m intervals. Over even a short distance this can incur significant costs. Whilst some existing elements of a road section (for example, intersections)

may also reduce speed, over any substantial area (for example, a suburb) many physical devices could be required and could result in a substantial cost (Austroads, 2008b).

It must also be noted that use of some physical methods can also have adverse effects, such as increased noise and vibration at speed humps, and additional acceleration / deceleration of vehicles between devices (Austroads, 2008b). It is assumed for the purposes of this report that any use of physical measures is undertaken, in accordance with local conditions and best practice, to minimise any such adverse effects.

3.2.1.3 Visual cues

Visual cues act to reduce drivers speed by making faster speeds feel inappropriate rather than physically requiring drivers to reduce their speeds. Standards New Zealand (2010a) addresses target operating speeds for new roads. It identifies that target operating speeds can be managed by devices such as narrow movement lanes, reduced forward visibility, and landscaping.

Two key geometric factors that contribute to achieving the target operating speed are carriageway width and forward visibility. Different combinations of these two factors can be used in the design of new roads (or redesign of existing roads) to achieve the desired operating speed as shown in Figure 5 (Standards New Zealand, 2010a).

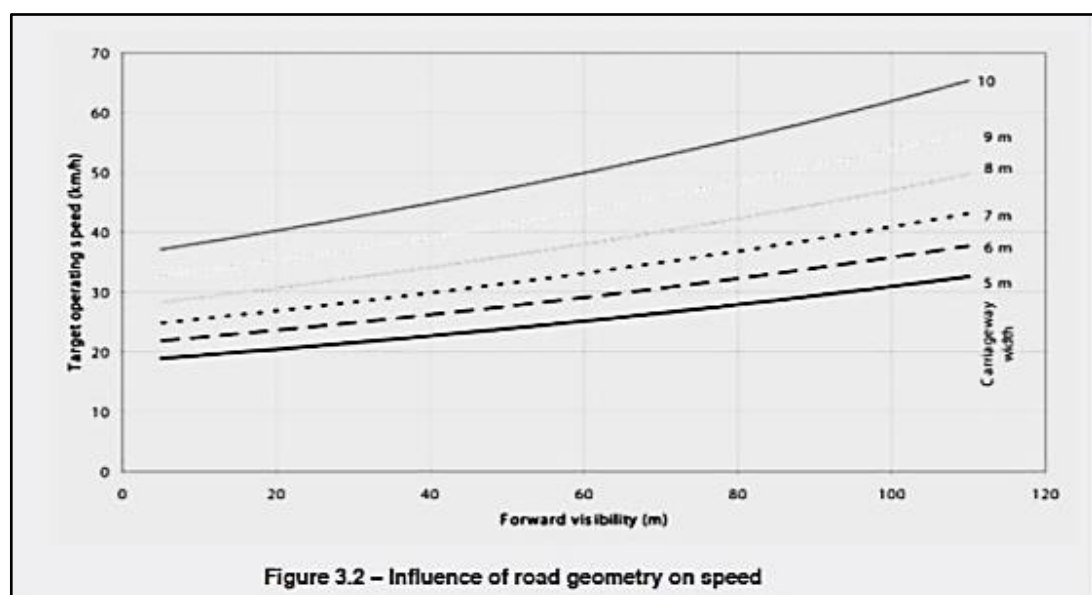


Figure 5: Relationship between visibility, carriageway width, and operating speeds (Standards New Zealand, 2010a)

The relationship shown in Figure 5 (adopted from international guidance) reflects drivers choice to reduce speed when forward visibility is reduced and / or the carriageway narrows the driver's field of vision (for example, by tree plantings) (Austroads, 2008b). A comparative study of different street types, in Vancouver (Washington), also identified a linear relationship between road width and motor vehicle speed. The relationship suggested that for every one metre of additional road width, vehicle speeds increased by 1.6 km/h. The proportion of vehicles travelling over the posted speed limit also increased linearly, with increasing road widths (Victoria Transport Policy Institute, 2011).

Reducing the lateral clearance (space adjacent to the trafficable area) can also reduce speeds, for example, where less than one metre clearance is provided, free speeds would be expected to reduce by around 9 km/h. Reducing lane widths to 3.5 m wide or less would also be expected to reduce the free speeds by 3 km/h (New Zealand Transport Agency, 2010). Marking of cycle lanes on Pages Road in Christchurch (visually narrowing the carriageway) lead to a 0.9 km/h reduction in mean speeds, in the peak hour, and 1.5 km/h reduction in off peak periods (Parsons, 2012).

Other factors can also act as visual cues such as the level of roadside development and presence of pedestrians and cyclists (New Zealand Transport Agency, 2003). For example, where there are more than 40 access points per kilometre, the free speed of vehicles is likely to be around 9 km/h lower (New Zealand Transport Agency, 2010).

Use of visual cues to reduce speed may result in a more consistent speed profile than that observed where physical devices are used. Whilst narrowing the carriageway may be expensive for existing roads this could reduce costs within new subdivisions. Other opportunities may also exist to reduce costs, such as reducing the carriageway width during road maintenance, upgrades, or kerb and channel renewals. The use of lane markings could provide a less expensive alternative.

3.2.1.4 Successful implementation of speed reductions

In terms of speed limits below 50 km/h, "Speed Limits New Zealand" (New Zealand Transport Agency, 2003) came into effect in 2004 and lower speed limits have been used in specific locations in cities within New Zealand (and a wider application is proposed in

Wellington and Hamilton). The primary justification for these has been safety, particularly where shared zones are created (O’Fallon & Sullivan, 2011).

The limited application of lower speeds in New Zealand and lack of comprehensive before and after studies, means that it is difficult to determine whether the effects observed internationally, would eventuate in New Zealand conditions. That said, there is no inherent reason why the results should be different. For example, research undertaken by Charlton and Baas (2006) included some brief observational samples of speed changes for various road widths, use of centre lines, and central medians, in New Zealand and found that their results were consistent with that anticipated, based on literature.

In reality controlling urban speeds effectively is likely to require a package of approaches including: speed limits, physical devices, and / or visual cues, as well as enforcement. This recognises that using speed limits leads to only small reductions in traffic speeds (Department for Transport, 2012). Typically physical devices and visual cues tend to have a greater effect on a drivers’ speed choice than the actual speed limit (Archer et al., 2008). Therefore whilst there may be occasions where speed limits, physical devices, or visual cues, can be appropriately applied in isolation, greater speed reductions typically require a combination.

Successfully changing speeds requires careful implementation. In order to be successful, information should be provided to the public and decision makers regarding the problems associated with speeding, the reasons for the desired speed and highlighting the positive outcomes (for example, safety & environmental benefits) (OECD, 2006; Austroads, 2008a). Particularly where wide-spread changes are proposed, information campaigns, e.g. by billboards alongside the road, or messages on television, should accompany any changes. It is however noted that information campaigns are likely to have little effect if they are applied as a stand-alone measure (OECD, 2006).

It must be acknowledged that many motorists object to frequent speed changes over a short distance. If there are a number of locations where reduced speeds are appropriate, in relatively close proximity, consideration should be given to extending the reduced speed zone over a longer section (Austroads, 2008a). Generally frequent changes in speed limits

should be avoided and minimum lengths should apply (New Zealand Transport Agency, 2003).

Internationally there are examples of reduced urban speeds being applied at different scales, ranging from local or neighbourhood streets, through to city-wide (O’Fallon and Sullivan, 2011). For example, by 2008 there were 399, 20 mph speed limit (equivalent to 30 km/h) zones in London, covering around 2,216 km of roads ranging from 0.07 km to 37 km in length.

In summary whilst there are few New Zealand examples there appears to be no reason that reduced speeds cannot be successfully implemented in New Zealand.

3.2.2 Time and Costs

Archer et al. (2008) cited research by Haworth et al. (2001) into the costs of implementing the 50 km/h speed limit (replacing the previous 60 km/h default urban speed limit) on all local, collector and arterial roads, in urban areas, of Australia. They estimated the cost of this was around \$2.8 million including signage and media campaigns.

Wellington City Councils safer roads project planned suburb-wide 40 km/h speed restrictions, as part of a major programme of changes, costing \$21 million over 7 years. By 2011 many of the traffic management measures (some of which would encourage traffic speeds as low as or lower than 40 km/h) had been implemented in seven treated areas incorporating 12 suburbs. Speed limit changes however had only been implemented in two suburbs (40 km/h in Newtown and 30 km/h in part of the Lambton area). More recently, Council began a four-year plan to implement 30 km/h zones in 21 suburban shopping areas some of which will be less than 200 m in length. Lower speeds have also been implemented, on a smaller scale, in a number of urban locations in New Zealand (O’Fallon & Sullivan, 2011).

The implementation of lower speed areas suggests that the time and cost requirements are achievable in some locations within New Zealand.

3.2.3 Legislation

Legislative requirements also affect how efficiently speed changes can be implemented.

In England, 20 mph zones have required entry and exit signs and traffic calming features every 50 m (unless in a cul de sac of less than 80 m in length). The government has however recently made changes to this legislation to facilitate and reduce the cost of providing 20 mph zones. Some traffic calming features are allowed to be replaced with repeater speed signs or a speed roundel road marking. There is still a requirement for a minimum of one traffic calming feature and signs at no more than 100 m apart (Department for Transport, 2012).

A brief outline of the relevant New Zealand legislation is provided below.

3.2.3.1 Speed Limits in New Zealand

The speed limit in New Zealand is generally 50 km/h for roads in urban⁵ areas and 100 km/h for rural roads. However other speeds (in multiples of 10 km/h) between 10 and 90 km/h can also be adopted. The “Land Transport Rule: Setting of Speed Limits” (Ministry of Transport, 2004) sets out the legal procedure for establishing speed limits on public roads in New Zealand. This incorporates “Speed Limits New Zealand” (New Zealand Transport Agency, 2003) as the procedure for calculating the speed limit.

“Speed Limits New Zealand” (New Zealand Transport Agency, 2003) allows for urban speed limits of 20-60 km/h where traffic patterns, road or land use conditions make one of these speed limits appropriate and safe.

Road controlling authorities (predominantly Councils and the New Zealand Transport Agency) are required to use Speed Limits New Zealand to calculate speed limits for any public road. This ensures consistent speed limits across the whole road network. The calculations include consideration of the existing speed limit, character of surrounding land uses, road function, detailed roadside development data (e.g. number of houses / shops), number and nature of side roads, characteristics of the carriageway, vehicle cycle and pedestrian activity, crash data, and speed survey data (New Zealand Transport Agency, 2003).

⁵ An urban traffic area is “land close to or within a town or city, the land will generally appear fully built-up”. This includes residential, commercial, industrial, educational and recreational land uses. An urban traffic area is also considered to include partly built-up areas such as small towns, within a metropolitan area and on the fringes of a metropolitan area.

Section 2.1 of Speed Limits New Zealand sets the urban speed limit (50 km/h) as the general speed limit to apply, where drivers can expect to encounter other vehicles turning, slowing , stopping or parking as well as pedestrians, cyclists, and heavy vehicles (New Zealand Transport Agency, 2003).

Speed limits of 20, 30, and 40 km/h can be set for local roads or minor collector roads, in urban traffic areas, where the road is used by motorised traffic and pedestrians or cyclists, and a speed limit of less than 50 km/h is necessary for safety purposes. It states that “these limits can only be set if the calculated speed limit for the road is 50 km/h and appropriate and safe traffic engineering techniques are applied, to ensure that the mean operating speed of motorised traffic is kept to within 5 km/h of the speed limit” (New Zealand Transport Agency, 2003).

When reviewing the speed limit the road controlling authority must undertake the following considerations (New Zealand Transport Agency, 2003):

- Surveys of roadside development and activities;
- Road environment including the length of the restriction and road geometry;
- Correct signposting to ensure the speed limit is enforceable and to encourage compliance. As a minimum a sign is required within 20 m of the point where the speed limit changes;
- Mean operating speeds should be the same or less than the speed limit for 50-100 km/h roads and 85th percentile speeds should be no more than 10 km/h above the speed limit;
- For speed limit changes on arterial roads the overall injury crash rate should be compared with national data (also recommended practice for other roads);
- A safety audit appropriate to the location and function of the road should be conducted particularly when an increase in the speed limit is proposed;
- All parts of the process should be documented to allow for future reviews, auditing and support for any legal processes;

- The speed limit should be regularly reviewed to ensure speeds are consistent with changes to the area and monitoring should include roadside development, road environment, operating speeds, crashes, signposting and documentation.

From the above information an average rating is calculated based on an average of the development and roadway ratings. The development rating (i.e., one dwelling is one unit) is determined from 'Table SLNZ4 Frontage development rating units' and is based on the sum of expected daily vehicle, cycle and pedestrian movements, associated with the type of land use, along the each 100 m long road section. Development along the first 500 m of side roads is also included and based on a different rating as set out in 'Table 5 Side road development rating units' (New Zealand Transport Agency, 2003).

The roadway rating is calculated by adding together the ratings from roadway activities, such as pedestrians, parking, traffic controls, the frequency of activities, and the proximity to through-traffic. Roadway rating units are specified in 'Tables SLNZ6- SLNZ11' for the various aspects (e.g. cyclists, pedestrians, parking). Roadway ratings are also undertaken in 100 m sections, with the total being the sum of all sections. The total roadway rating should not generally exceed the total development rating and should be reduced to equal the development rating if it does (New Zealand Transport Agency, 2003).

The average rating is calculated by adding the total roadway rating and the total development rating and then dividing by the number of 100 m road sections. The average rating is then applied to flow charts which allow 20, 30, or 40 km/h speed limits, on local or collector roads, with an average rating of 11 or greater and where engineering measures are used to control speed (New Zealand Transport Agency, 2003).

After calculating the new speed limit the road controlling authority must consult with affected parties, make a bylaw, notify police, record the details in a register, and erect speed limit signs (New Zealand Transport Agency, 2003).

The legislation allows for speed limits of less than 50 km/h however the process is not perfect. There is for example, a lack of recognition of future pedestrian or cycle volumes if reduced speed limits will result in numbers increasing (i.e., if there is suppressed demand due to the existing road environment being unfriendly for pedestrians and cyclists). There is also a lack of recognition where there is high demand for crossing the road, but no physical

facilities are provided. The presence of geometric features (for example, reduced visibility, medians, or narrower traffic lanes) is not well included in the roadway ratings. Speed limits of less than 50 km/h are not recommended on collector and arterial roads, which ignores the mixed use function they may actually serve in some locations. Finally there is no explicit rating that recommends a lower speed limit is appropriate (just guidance on when it may be allowed) (Koorey, 2011). A number of changes to recognise these factors would be beneficial.

3.2.3.2 Speed enforcement in New Zealand

Other than speed limits, vehicle speeds in New Zealand are also managed by way of enforcement. Enforcement of speed limits is undertaken by the New Zealand Police. The Police use a mixture of stationary and hand held (mobile) speed cameras and are responsible for testing equipment, selecting sites for enforcement (in consultation with the New Zealand Transport Agency, local government and the New Zealand AA⁶), issuing tickets and responding to queries (New Zealand Police, 2012).

The police “Speed Enforcement Guide” (New Zealand Police, 2012) recognises that proactive enforcement to change road user behaviour, is most effective due to its wide deterrent effects. It also recognises that a consistent approach to enforcement is necessary to reduce mean speeds. Generally speed infringements (tickets) are issued where a vehicle is more than 10 km/h over the speed limit (New Zealand Police, 2012).

Vehicles exceeding the speed limit by less than 11 km/h, would receive an infringement fee in the vicinity of \$30. Fees increase exponentially with speed, up to a maximum of \$630 per fine. Drivers exceeding the speed limit by 41 km/h or more face mandatory suspension of their license for 28 days. Drivers exceeding the speed limit by more than 50 km/h can be charged with dangerous, reckless or careless driving (New Zealand Police, 2012).

Unpaid infringement tickets are referred to the Ministry of Justice and become a more serious fine (which is then paid through the court system). Demerit points are also issued for

⁶ New Zealand Automobile Association.

instant speed infringements. Money from speeding tickets goes into the Governments consolidated fund (not to police or local authorities) (New Zealand Police, 2012).

3.2.4 Industry knowledge

Internationally there is a growing volume of literature on reducing urban speeds, as well as a number of examples, where this has been applied. Some examples are outlined below.

Oxfordshire County Council has 20 mph limits on most residential roads, which are achieved through use of signage and not physical engineering measures (O’Fallon & Sullivan, 2011).

The Woonerf or home zone originated in the Netherlands, to reduce speeds on residential streets. The concept centres around shared zones to reduce operating speeds by allowing non-motorised modes, children playing, and vehicles, to share and negotiate the use of the road rather than provision of footpaths and traffic lanes (O’Fallon & Sullivan, 2011). In the United Kingdom home zones have been applied at various scales, for example, the Methleys in Leeds (14 streets and 300 homes), Northmoor in Manchester (1,400 homes) and Magor in Monmouthshire (60 homes and 20 small shops). A variety of physical measures are used to suit the local area however, nearly all home zones have gateway treatments to clearly define them (O’Fallon and Sullivan, 2011).

Mixed priority routes were devised by the Department for Transport to address diverse traffic and mixed uses on high streets and shopping streets in the United Kingdom. They essentially seek to reduce casualties and make better use of space, improving amenity without displacing traffic onto other roads. Measures adopted include: shared space junctions, diagonal pedestrian crossings, reduced speeds through physical measures such as narrowings, improved parking and loading arrangements, reducing street clutter, shared use of roadways for cyclists and vehicles, and beautifying public streetscapes (O’Fallon and Sullivan, 2011).

There are a variety of shared space concepts used. Austroads (2009) suggests that shared space areas are suitable on roads with less than 5,000 vehicles per day, however, one has been implemented in the Netherlands at an intersection with around 20,000 vehicles per day. Generally speeds need to be 40 km/h or lower (O’Fallon and Sullivan, 2011).

Most guidance on reducing urban speeds comes from research reports and case studies or from government, particularly councils.

Guidance documents widely available in New Zealand are limited, but include: Austroads (2008b) “Guide to Local Area Traffic Management”, and “Land Development and Subdivision NZS4404:2010” (Standards New Zealand, 2010b). There is also the “Guidelines for urban- rural speed thresholds RTS 15” (Land Transport Safety Authority, 2002), however, this does not cover speeds below 50 km/h. The following “Traffic Notes” (NZTA, 2013) also relate to speed in urban areas:

- Traffic Note 35: Guidelines for urban-rural thresholds – information,
- Traffic Note 37: 40 km/h variable speed limits in school zones – guidelines,
- Traffic Note 43: Speed limits less than 50 km/h – guidelines, and
- Traffic Note 56: Active school warning signs – guidelines.

“Traffic Note 43” (New Zealand Transport Agency, 2013) is of most relevance to the general use of lower urban speeds, however provides only a brief summary of the key points in “Speed Limits New Zealand” (New Zealand Transport Agency, 2003).

Notable examples of experience with lower speed limits in New Zealand, include a 30 km/h speed limit in Hamilton Central City, 40 km/h school zones (in various cities) and implementation of five 30 km/h speed zones on shopping streets in Wellington. Some speed reductions have also occurred without changes in speed limits, for example, self-explaining road trials at Point England in Auckland, Living Streets projects in Christchurch and a variety of local area traffic management examples. There is however limited information available as to the success of these measures (Koorey, 2011).

Given the relatively slow uptake of lower speed limits in New Zealand, some published guidance on how to achieve lower urban speeds in New Zealand, could be beneficial either to fill the gaps in the legislation or in addition to the changes discussed in section 3.2.3.1.

3.2.5 Public opinion

Public opinion towards speeds and speed limits is slowly changing, with a growing awareness of the link between speed and road safety. In a number of countries there is

growing public support and pressure for reducing speeds on urban roads, particularly in residential areas (OECD, 2006). For example, surveys in Norway indicated that 73% of the population considered that there should be a 30 km/h speed limit in residential areas and 40% considered it should apply to all urban roads (OECD, 2006). In Australia around 30% of the population support 40 km/h urban speed limits, although support is higher in South Australia where a 40 km/h speed limit trial had previously been undertaken. The reason public attitudes towards lower speeds are improving appears to reflect not only a desire for improved safety but also a desire for improved amenity (Dyson et al., 2001a).

Public opinion surveys in New Zealand are limited. Community consultation for a 40 km/h limit on Ponsonby Road in Auckland (in 2009) received 736 responses of which 79% were in support and only 18% opposed the change (the remaining responses did not indicate a clear view). The feedback also included a petition with more than 600 signatures supporting the proposed reduction of the speed limit from 50 km/h to 40 km/h. Some of the key reasons related to an opinion that the existing road environment was unpleasant (“like a highway”), there was no sense of community, and they wanted a more pedestrian friendly street (Hay, 2009).

A survey of residents' opinions on reducing the speed limit to 30 km/h in Point Chevalier, Auckland, undertaken by Slower and Less Traffic (SALT), revealed 89% support for areas near schools and 69% support for application to the whole neighbourhood (Woodward, 2009).

It is difficult to gauge the overall level of public support for reducing urban speeds, however there is nothing to suggest that the public are opposed to this. The surveys above suggest the opinion of New Zealanders may be similar to some countries overseas where there is increasing support for reduced speed limits at least in residential areas.

3.2.6 Political opinion

In the United Kingdom the government is encouraging and providing guidance, to local authorities, to introduce 20 mph zones and also 30 mph limits in villages to improve safety and quality of life (OECD, 2006). The government has released “Setting Local Speed Limits” (Department for Transport, 2012) providing guidance for councils as to how to implement lower speeds within their district. It is evident from the reasonably large number

of 20 mph zones, in the United Kingdom, that strong political support and guidance at central government level has encouraged uptake of lower speeds. Although the New Zealand “Road Safety Strategy” (Ministry of Transport, 2010) identifies reducing speeds as a key tool for improving road safety there is no comparable encouragement from central level government in New Zealand.

Uptake of lower urban speeds appears to vary between local authorities within New Zealand. For example, Hamilton and Wellington City Councils are taking a proactive approach to implementing lower urban speeds. It is not clear if this reflects a greater level of local authority direction, or simply initiatives by industry professionals, and / or responses to community pressure.

Overall the slow uptake of lower speed areas in New Zealand suggests that there is not a strong political drive to reduce urban speeds as has occurred in the United Kingdom. There is nothing to suggest that there is unwillingness, at central or local government level, to support lower urban speeds, simply it is not a priority.

3.3 Summary of efficiency of reducing urban speeds

The likely success of reducing urban speeds, the time and cost to implement, legislation, public and political opinions, as well industry knowledge, are all likely to affect how efficient implementation of lower urban speeds is.

Physical measures, visual cues, and legal methods, (all used in accordance with best practice) can all achieve reductions in speeds, however to different degrees. Typically legal measures (speed limits and enforcement) will achieve the least reduction and the best results occur where a combination of methods are adopted.

The time and cost of implementation appear to vary substantially. Limited budgets could constrain the implementation of lower speeds where substantial physical works to the road are required. That said, examples of lower speed limits in Wellington and Auckland show that reducing urban speeds is achievable.

The current legislation allows local authorities in New Zealand to implement speed limits below 50 km/h where the road environment supports this. It appears however that there are a number of improvements that could contribute to a greater level of adoption by local

authorities. There is a growing, but still limited, body of literature on reducing urban speeds particularly in the New Zealand context. It is however unclear to what extent relevant professionals are being exposed to this literature and the level of knowledge within the industry generally.

From the limited information on public opinion available it appears that residents are generally supportive of reduced speed limits in residential areas.

It is evident that strong political support and guidance at government level in the United Kingdom has encouraged the uptake of 20 mph (32 km/h) speed limits by territorial authorities. Although in New Zealand the road safety strategy identifies reducing speeds as a key tool for improving road safety, the level of support from central level government is not comparable to that in the United Kingdom. Uptake of lower urban speeds varies between local authorities within New Zealand.

3.4 Effectiveness of reducing urban speeds

Having considered the efficiency of reducing urban speeds the following discussion considers how effective reducing urban speeds would be to achieve sustainable land transport outcomes. The effectiveness of reducing urban speeds, in terms of sustainable land transport, can be considered in respect to the seven building blocks outlined above. The key speed-related effects in respect to each building block are listed below:

- Safety: crash rates, crash severity.
- Accessibility: impact on different modes and peoples need for transport.
- Environmental sustainability: vehicle emissions, energy use, mode shift.
- Public health: noise, air quality, impact on physical exercise / use of active modes.
- Functional transport networks: delay, congestion, travel time variability, route choice.
- Economic development: cost of increased travel times, direct effects on nearby businesses.
- Integrated urban form: livability, amount of land required.

The effects of reducing urban speed, on each building block, are discussed in the following sections.

3.4.1 Safety

The New Zealand Government has adopted a safe system approach to road safety (National Road Safety Committee, 2010). A safe system approach recognises that even responsible drivers sometimes make mistakes and that the road transport system needs to protect people from death or serious injury. This includes managing the forces involved in accidents to a level which the human body can tolerate without serious injury (National Road Safety Committee, 2010). Recognising that speed is the single greatest determinant of the forces that occur in a crash, appropriate speeds are an integral part of the safe systems approach to road safety (Austroads, 2008a).

Reducing speed limits, with associated enforcement and education, will reduce the speed of the fastest vehicles, reducing speed variance, mean speeds, and crash risk (Austroads, 2008a).

In terms of international examples, Sweden (and some other northern European countries) has adopted a 'Vision Zero' safety policy. Speed reduction is the single most important aspect to achieving this vision and roads are designed based on the most vulnerable road users (WHO, 2002).

Similarly, in the United Kingdom, York City Council recognised that reducing speeds was the best way to reduce crashes and pioneered a danger reduction approach to speed management. Implementation of this approach has achieved the casualty reduction targets well in advance of target dates (WHO, 2002).

The relationship between reducing speed, the likelihood, and severity of crashes is complex. Reducing speed not only reduces the forces which occur in an accident, but also increases the time for road users to observe and react to a crash situation arising. At slower speeds, drivers have a wider field of vision and are therefore more likely to observe and react, to potential crash situations. Slower speeds also reduce the distance travelled during the reaction and braking times (for example, between a 30 km/h and 40 km/h travel speed the braking distance increases from 13.5 m to 20 m). Lower speeds also make it less likely that the driver

will lose control of the vehicle, when undertaking heavy breaking or avoidance manoeuvres (Austroads, 2008a; Dekoster & Schollaert, 1999; Department for Transport, 2012).

The relationship between speed and accidents has been well studied and there are reasonably consistent generalisations of this correlation as shown in Figure 6.

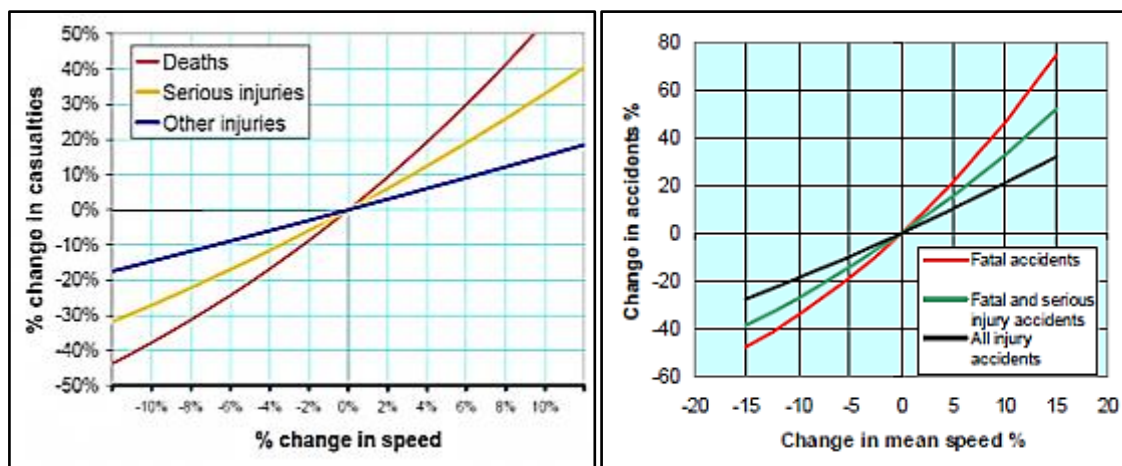


Figure 6: Relationship between speed and casualties (Left: Elvik et al., 2004⁷, and Right: Nilson, 2004 in OECD, 2006)

The graphs show that a small decrease in speed, has a proportionately larger decrease in accident rates. For example, a 5% reduction in speed, would be expected to result in a 10% reduction in all accidents, including a 20% or greater reduction in fatal accidents.

Table 4 identifies similar trends and includes the relationship for property damage crashes (Elvik et al., 2004).

⁷ The graph on the left was developed from data recorded on both rural and urban roads (speeds between 25 and 120 km/h) in over 20 countries between 1966 and 2004.

Table 4: Relationship between speed and accident rates (Elvik et al., 2004)

Change in mean speed						
Change in	Speed reduction			Speed increase		
	-10%	-5%	-1%	+1%	+5%	+10%
Deaths	-38%	-21%	-4%	+5%	+25%	+54%
Serious injuries	-27%	-14%	-3%	+3%	+16%	+33%
Other injuries	-15%	-7%	-1%	+2%	+8%	+15%
Property damage	-10%	-5%	-1%	+1%	+5%	+10%

The chances of mortality increase significantly above different speed thresholds, for different types of crashes, for example, vehicle collisions with a stationary object at 30-40 km/h and for pedestrians or cyclists hit by a vehicle at 20-30 km/h (Austroads, 2008a).

The impact of speed on severity of pedestrian – vehicle crashes is significant. Rosen & Sander (2009) undertook a comprehensive study of the risk of adult pedestrian fatalities from front on collisions with vehicles. The study concluded that the risk of fatality at 50 km/h was twice that at 40 km/h and more than five times higher than at 30 km/h. The results are summarised in Figure 7 and Figure 8.

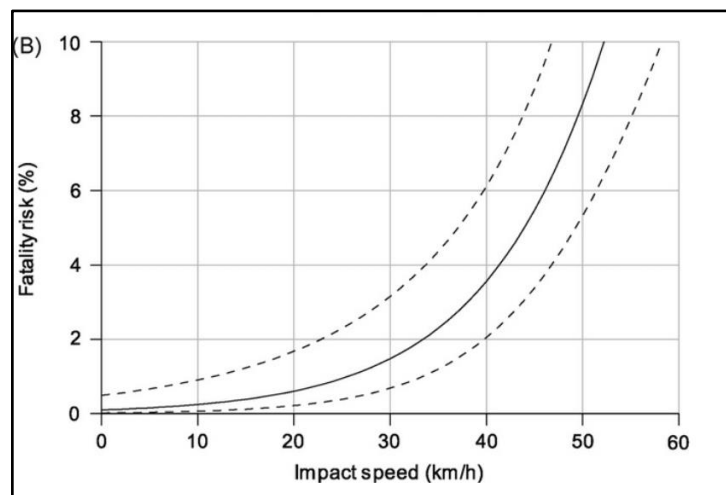


Figure 7: Risk of fatality to adult pedestrians associated with impact speed of vehicle (Rosen & Sander, 2009)

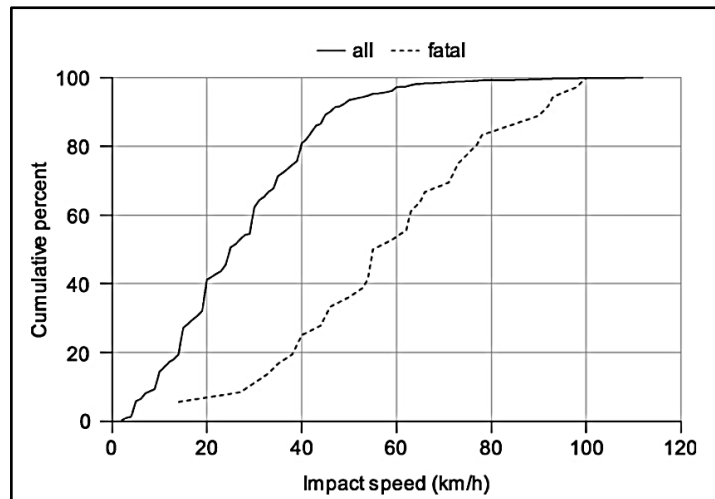


Figure 8: Risk of all injury and fatal injuries associated with front-on vehicle impact speed (Rosen & Sander, 2009)

There is limited research specifically considering the injury risk to cyclists with most assuming a similar (if not higher) risk as that for pedestrians.

There have been numerous studies of crash rates from reduced urban speeds. For example, a study by Webster and Mackie (1996, in O’Fallon and Sullivan, 2011) found a 60% reduction in crash frequency overall from the introduction of 30 km/h zones in the United Kingdom. Research by Grundy et al. (2008, in O’Fallon and Sullivan, 2011) showed a 42% reduction in all casualties when compared to areas that did not have 30 km/h zones. Whilst there are variations in the resultant crash reductions, there is a reasonably well agreed correlation between reducing speeds and improving road safety.

3.4.2 Accessibility


Concerns relating to the speed of vehicles may discourage some people from walking or cycling, or restrict their ability to use the most direct or desirable route. Such effects are difficult to quantify but can still have a considerable impact on the people concerned (OECD, 2006; Victoria Transport Policy Institute, 2011).

New Zealand Transport Agency (2009) lists a number of factors that put people off walking including: speeding vehicles, traffic fumes, and noise. The guide states that people are more likely to walk if they see the area as being walking friendly.

The friendliness of a road for walking is influenced by a variety of characteristics, including the speed of vehicles. In high pedestrian areas traffic speeds should be determined by pedestrian needs in order to improve permeability for pedestrians (New Zealand Transport Agency, 2009). Speed moderation noticeably affects pedestrian and cyclists perception of the road, with slow traffic areas typically being less stressful than similar roads with faster traffic (Dekoster & Schollaert, 1999). For example, a survey of residents regarding the 20 mph speed limit in Somerset Street (United Kingdom) indicated that 82% of residents thought their street was more welcoming and easier to walk around and 17% planned to cycle more (Sustrans, 2011).

In terms of providing for pedestrians within the road corridor, the New Zealand “Pedestrian and Planning Design Guide” (New Zealand Transport Agency, 2009) recommends reducing traffic speeds as the second most preferable option (to reducing traffic volumes) as shown in Table 5 below. This guide appears to be based on best practice adopted from overseas research and guides.

Table 5: Hierarchy of provision for pedestrians within the road corridor (New Zealand Transport Agency, 2009)

Measure to provide for pedestrians	Priority
Reducing traffic volumes on the adjacent roadway	<u>Consider first</u>  <u>Consider last</u>
Reducing the traffic speed on the adjacent roadway	
Reallocating space in the road corridor to pedestrians	
Providing direct at-grade crossing treatments	
Improving pedestrian routes on existing desire lines	
Providing new pedestrian route alignment and grade separation	

Reducing traffic and speed are identified as the highest priorities as they can also improve road safety, air quality, and noise, leading to an overall improvement in the quality of the environment (New Zealand Transport Agency, 2009).

Similarly, vehicle speed has an impact on peoples' decision whether or not to cycle. The influence speed has on this decision is increasingly important for less competent cyclists. In

new areas, neighbourhood street design considerations for cyclists should achieve slow mixed traffic (Land Transport Safety Authority, 2004).

Land Transport Safety Authority (2004) provides a five point hierarchy that considers reducing traffic volumes as the first option and reducing speeds as the second most preferable option (followed by adapting intersections, reallocating road space and providing cycle lanes / paths). This is also reflected in the level of service ratings⁸ which identify level of service C where 85th percentile speeds are around 50 km/h (when accompanied by light to moderate traffic flows, good road surface etc.) and levels of service A-B where speeds are low (no value specified but assumingly below the 50 km/h default urban speed limit) and accompanied by lower traffic volumes and good road surface etc. (Land Transport Safety Authority, 2004).

Fear of being the victim of crime (particularly theft or assault) also restricts the accessibility of some locations, particularly for some members of the community with a greater fear of crime. Careful design of public space can make the area less susceptible to crime and enable people to feel more comfortable using the space. The fundamental principle is to improve natural surveillance as people are less likely to commit a crime if they are, or think that they may be, observed (Canterbury Safety Working Party, 2004). It is well known that at higher speeds drivers have less time to see things but they also have a narrower field of vision (less focus at the periphery) (OECD, 2006). This would suggest that slower speeds may contribute to increased levels of casual surveillance by passing drivers. Overall, reducing speed is likely to improve accessibility however it is difficult to quantify the level of such benefits.

3.4.3 Environmental sustainability

Speed-related effects in terms of environmental sustainability include vehicle emissions and energy use.

3.4.3.1 Vehicle emissions

Common vehicle emissions include carbon dioxide (CO₂), carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x – including NO and NO₂) and particulate matter (PM).

⁸ Level of service ratings vary between A-F with A being the best.

Carbon monoxide is a byproduct of incomplete combustion. Vehicle emissions are one of the key sources of carbon monoxide in New Zealand urban areas. Nitrogen dioxide combines with water to form nitric acid and nitric oxide. Motor vehicle emissions are the main source of nitrogen dioxide in New Zealand urban areas. Nitrogen dioxide and volatile organic compounds also react with ultraviolet light to produce ozone (a highly reactive gas) (Environet Limited, 2003a). These gases have a variety of environmental effects.

Greenhouse gases (mainly carbon dioxide) and local pollutants (carbon monoxide, nitrous oxides, hydro carbons and particulates) emitted by vehicles can affect the environment (OECD, 2006).

Vehicle emissions vary with speed. Because reducing motorway speeds is understood to reduce vehicle emissions there is an expectation that a similar trend would be observed when reducing urban traffic speeds. In reality this is not the case, primarily because motorway speeds are typically higher than the most efficient operating speed of vehicles (in terms of vehicle emissions) whereas most urban speeds are at or below this threshold. To the contrary, widely used methods for estimating emissions using quadratic functions (for example, Copert and MEET models / equations) suggest that reducing vehicle speeds below 50 km/h could lead to a dramatic increase in emissions (Beckx & Broekx, 2006).

Whilst vehicles travelling at constant speed may not necessarily generate lower vehicle emissions at 40 km/h than 60 km/h, the opportunities to travel at constant speed in an urban area are limited. Higher speeds therefore produce a greater potential for higher emissions due to acceleration. Thus the relevant proportion of acceleration and constant speed (as well as deceleration and idle), become critical to the change in vehicle emissions, from reducing urban speeds (Dyson et al., 2001a).

Beckx and Broekx (2006) sought to consider the impact on vehicle emissions of the 30 km/h zones being adopted in Europe. Similarly, Woolley et al. (2001) sought to compare vehicle emissions between 60 km/h and 40 km/h zones being used in South Australia. Both these studies were based on real-life driving conditions measured from test trips undertaken in representative vehicles on roads in urban areas. The results are summarised below.

Woolley et al. (2001) considered the difference in fuel consumption and vehicle emissions between 60 km/h and 40 km/h speed limits. They used a chassis dynamometer, to obtain

engine maps for fuel and emissions levels for various levels of engine power and speed. Their test vehicle was a GMH VS Commodore sedan, driven in real traffic conditions. This enabled them to observe real pollutant emissions which were used in the Biggs-Akcelik model of fuel consumption and emissions (Dyson et al., 2001a).

They used the findings of Primerano and Zito (2000) on the difference in emissions for different acceleration and deceleration rates, on different street lengths. They thus adopted three different scenarios for potential driving behaviours (Dyson et al., 2001a).

- Scenario 1 - a slow conservative driver (accelerates slowly to the speed limit then cruises for a period of time at the limit, then decelerates slowly to rest),
- Scenario 2 - an average driver (accelerates at an average rate, cruises at the speed limit, then decelerates at the average deceleration rate of -3.5 km/h/sec), and
- Scenario 3 - an aggressive driver (accelerates hard to the speed limit, cruises at the speed limit for a period of time then decelerates at a high rate of -6.5 km/h/sec).

The results indicated that the medium and heavy acceleration scenarios produced similar total CO₂ emissions for the 40 km/h and 60 km/h speed limits. This reflected the smaller amounts of emissions being produced in both the hard acceleration and deceleration phases due to the shorter amount of time in each of those phases, which was balanced out by more emissions being produced in the cruise phase of the hard acceleration scenario (due to a longer time in the cruise phase) (Dyson et al., 2001a).

The results also showed a crossover point at street lengths of 550 m, where the total CO₂ emissions for the 40 km/h limit exceeds that for the 60 km/h limit, for both the medium and hard acceleration scenarios. For slow acceleration the emissions for the 40 km/h scenario are higher than the 60 km/h scenario. This means that for street lengths over 550 m CO₂ emissions are likely to be higher at 40 km/h than at 60 km/h. The amount of time spent cruising at 40 km/h compensates for the extra emissions produced, when accelerating from 40 km/h to 60 km/h and decelerating from 60 km/h to 40 km/h (Dyson, et al., 2001a).

The CO emissions show quite a different trend to that of CO₂. CO emissions for the 40 km/h speed limit remain lower than that for the 60 km/h speed limit. NO_x and HC show trends

more similar to the CO₂ emissions, except that the crossover points occur at different street lengths (Dyson et al., 2001a).

Overall Dyson et al., (2001a) suggest that determining the precise emissions outcomes is complex. For short street lengths (under 350 m), the 60 km/h speed limit will produce more emissions and for longer street lengths (over 1,000 m), the 40 km/h limit will produce more emissions (Dyson et al., 2001a). Any overall impacts would therefore need to carefully consider the typical street length and acceleration characteristics of a particular case.

Beckx and Broekx (2006) measured driving cycles for a VW Polo (Euro 4, Petrol), Skoda Octavia (Euro 3, diesel) and a Citroen Jumper light commercial vehicle (euro 3, diesel). These driving cycles were measured on roads in Mol, Belgium, and Barcelona, Spain, with a 50 km/h speed limit but in heavy traffic. From each of these driving cycles a driving cycle for a maximum speed of 30 km/h was derived (by limiting top speed but not altering acceleration or deceleration or total travel distance). These driving cycles were then analysed using VeTESS (Vehicle Transient Emissions Simulation Software). This allows fuel consumption and emissions for real traffic vehicle operation to be calculated in a dynamic and more accurate way than traditional models (which relied upon steady state engine maps) (Beckx & Broekx, 2006).

The HC and CO emissions results differed widely between vehicles but the volume of these vehicle emissions was so low that they couldn't be measured accurately (even a 100% change would be so low that it is close to the smallest amount that can be measured) (Beckx & Broekx, 2006).

The study concluded that there was very little change in respect to CO₂ emissions, the emission levels decreased for both cars but increased for the light service vehicle. Similarly, the NO_x emissions increased slightly for the light service vehicle but the emissions of both cars decreased by a moderate amount. In terms of Particulate Matter (PM) the study concluded that the emissions of PM from both diesel vehicles decreased by a moderate extent. The PM emissions from the petrol car could not be modelled in VeTESS (Beckx and Broekx, 2006).

The results are limited to the vehicles tested and cannot therefore be applied to a diverse vehicle fleet as would occur within any city. The authors however noted that the vehicles

studied were quite popular vehicles (based on car sales) and represent analogue models from other brands, as well as other cars with similar engines (Beckx and Broekx, 2006).

The study noted that acceleration or deceleration rates were not changed for the derived 30 km/h cycles and that different driving styles can have a noticeable impact on emissions. The general assumption is that reducing the speed limit would result in a more steady driving style and more fluent traffic flow. Some drivers could however vent their frustration at a lower speed limit, for example, by accelerating more quickly up to the speed limit (Beckx & Broekx, 2006).

Whilst neither of the studies could be assumed to apply directly to New Zealand urban areas, both consistently showed that there is not likely to be any significant change in vehicle emissions. Some emissions are likely to increase and others decrease, depending on the driving style and type of vehicle.

Research suggests that a 5% mode shift from light vehicles to bicycle travel in New Zealand would reduce travel by around 223 million kilometres and save about 50,000 tonnes of CO₂ which equates to about 0.4% of 2007 total domestic road transport greenhouse gas emissions. This equates to an annual cost of vehicle-related air pollution of approximately \$500 million (\$25 per 1,000 km travelled) (Lindsay et al., 2011).

3.4.3.2 Energy use

In terms of energy use there is a perception that lower speeds are less fuel-efficient. Swedish research has shown that constant speeds of 30 km/h tend to use more fuel than constant speeds of 50 km/h. Vehicles travelling at 30 km/h use less fuel in starting and stopping and thus the relationship between fuel use and speed is also complicated by urban driving conditions (Archer et al., 2008).

The level of CO₂ emissions represents an accurate indication of fuel use. This is because CO₂ is the main by-product of combustion. Thus the above conclusions in respect to CO₂ emissions directly apply to fuel usage. Both studies suggested that there was little change in CO₂ emissions between 40 km/h and 60 km/h maximum speeds and between 30 km/h and 50 km/h maximum speeds. As such fuel consumption and energy use are unlikely to noticeably change as a result of reducing urban speeds.

Other than the energy used to produce equipment (e.g. bikes) and additional energy uses of people when exercising rather than sitting, walking and cycling require no energy and do not require use of fossil fuels that are typically used to power motor vehicles. Thus converting even a small number of trips from private motor vehicle to walking or cycling contributes to reducing energy use. New Zealand research suggests that a 5% mode shift could save around 223 million kilometres of travel in New Zealand equating to a saving of about 22 million litres of fuel (Lindsay et al., 2011).

Data from the New Zealand 2003-2006 household travel survey indicated that 27% of vehicle trips in New Zealand were less than 2 km (approximately a 15 minute walk) and 70% were less than 7 km/h (7 km being approximately 30 minutes by bicycle) (Lindsay et al., 2011). It is therefore assumed that there are a number of opportunities to move some of these short vehicle trips to walking or cycling.

The Department for Transport (2012) recognises that 20 mph (32 km/h) zones, in the United Kingdom, may contribute to modal shift towards more walking and cycling. O’Fallon and Sullivan (2011) reviewed a number of studies where speed reductions had been implemented. In the studies where walking and cycling was measured, 16 studies had increased pedestrian volumes while 11 studies had no change or decreases, 6 studies showed increased cycling and 7 decreased or had no change. On this basis, O’Fallon and Sullivan determined that the results were inconclusive. They noted that sparseness and inconsistency of results meant establishing an evidence based positive relationship is a long way off. They identified the following difficulties in conclusively proving relationships between reduced speed and mode shift (O’Fallon and Sullivan, 2011):

- Often many other changes occur during the post monitoring periods (i.e., changes on other nearby roads or other initiatives such as school travel plans and increases in petrol price);
- Particularly when speed reductions are applied over a small distance there is a need to measure displacement of vehicles to, and pedestrians and cyclists from, other streets;
- Walking and cycling volumes can be influenced by weather and season; and,

- There is a lack of robust before data, control data and / or data is not measured in a way that allows statistically significant comparisons.

Whilst the results on mode shift have been inconclusive, well accepted fundamental principles of planning for pedestrians and cyclists suggest that reducing speeds should encourage increased use by pedestrians and cyclists. The discussion in section 3.4.2 outlines how reducing urban speeds can improve accessibility for pedestrians and cyclists. This suggests that particularly where existing speeds may be suppressing demand, mode-shift would be likely. On other roads this may simply make the experience more pleasant for existing users.

Safety concerns, predominantly fear of accidents and injury, are one the major reasons for people not cycling (British Medical Association, 1992). As outlined in section 3.4.1 reducing urban speeds is likely to reduce the number of crashes and particularly the number and severity of pedestrian and cycle crashes. Without public education and awareness of crash reductions associated with reduced speeds there may be a delay in people's perception of the improvements in road safety. This would suggest that there could be a considerable lag between reducing the speed and increases in the number of people choosing to cycle. It may not, therefore be surprising, that studies undertaken only one or two years before and after implementation, do not identify any change in travel mode.

It is concluded that reducing urban speeds has the potential to contribute to mode shift. It appears that the extent to which this occurs is both variable, and difficult to accurately measure and predict. More comprehensive and longer term studies are necessary to enable reliable conclusions.

3.4.4 Public health

Perhaps the most significant effect on public health is due to reducing the number of fatalities and injuries sustained during road crashes. The safety benefits were outlined in section 3.4.1 above. The discussion in this section will focus on other effects on public health associated with speed reductions. This includes encouraging or allowing more physical activity, improving air quality and reducing noise.

3.4.4.1 Air quality

The WHO (2002) suggests that motor vehicles could contribute to around 80% of air pollution in urban areas. Motor vehicles are “*the largest single contributor to urban air pollution in Australia’s major cities*” (Archer et al., 2008). Vehicle emissions including carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter (PM), volatile organic compounds and benzene affect urban air quality. These emissions can also affect human health (Archer et al., 2008).

There is growing evidence for a link between PM emissions and health effects, and any decrease in PM emissions could have a public health benefit in urban areas (Beckx & Broekx, 2006).

Carbon monoxide impacts on health by binding to haemoglobin instead of oxygen meaning that less oxygen is transferred around the body. This can affect the brain, nerves and heart muscle, resulting in temporary or permanent damage to these tissues (Environet limited, 2003). New Zealand ambient air quality guideline values for CO are 30 mg/m³ (one hour average) and 10 mg/m³ (eight hour average) (Ministry for the Environment, 2002). The concentration of CO is within recommended levels within most urban areas of New Zealand, except some suburbs in Christchurch, and road sides in Auckland, Wellington and Christchurch (Environet limited, 2003a). There is some evidence that health effects can occur below the New Zealand guideline levels (Dennison et al., 2000). The critical aspect is the degree of human exposure in locations where higher levels of CO occur (Environet Limited, 2003a).

Nitrogen dioxide is toxic to animals including humans, due to the creation of nitric acid when in contact with water. This can affect eyes, lungs, mucus membranes, and skin. Those with existing conditions, such as asthma, can suffer lung irritation and potentially damage, when exposed to high concentrations. It can also increase daily mortality and hospital admissions, from respiratory and cardiovascular effects. Because the results of studies are not consistent the guideline air quality levels include a 50% safety factor. The New Zealand ambient air quality guideline values are 200 ug/m³ (one hour average) and 100 ug/m³ (24 hour average). In most parts of New Zealand nitrogen dioxide concentrations are much less

than the air quality guideline values, with the main exception being roadside levels in Auckland (Environet Limited, 2003a).

The health-related effects of ozone (created from nitrogen dioxide and volatile organic compounds reacting with ultra violet light) have been widely studied and include: increased daily mortality and hospital admissions from respiratory and cardiovascular disease, decreased lung function and increased bronchodilator use, and symptoms of respiratory illness such as cough, phlegm and wheeze (Environet Limited, 2003a). The New Zealand ambient air quality guideline values are 150 ug/m^3 (one hour average) and 100 ug/m^3 (eight hour average) (Ministry for the Environment, 2002). Literature however suggests that there is no threshold of exposure below which no effects occur (Dennison et al., 2000). There have been limited measurements of ozone levels in New Zealand urban areas, but the effects are difficult to determine because human exposure rates are uncertain. Initial estimates, for Auckland, suggest that it may contribute to over 100 deaths per year (deaths brought forward) (Environet Limited, 2003a).

The majority of the monitoring of particulate matter in New Zealand has focused on PM_{10} sized particulates (particulate matter less than 10 micrometres in size). This is because larger particulates tend to settle in the nose and mouth, and are unlikely to penetrate further. Smaller particulates may penetrate into the lung and alveoli, causing more severe health effects. A number of studies have determined that higher concentrations of particulates increased mortality rates. Many urban areas in the South Island of New Zealand regularly exceed ambient air quality guidelines (50 ug/m^3 24 hour average). Concentrations are not generally as high in the North Island, however many areas experience concentrations in excess of the guideline levels. These levels can be due to many sources including: local industry, sea spray, dust, and motor vehicle emissions. The source of such concentrations may influence the level of effect (i.e., sea spray is not likely to cause health effects) (Environet Limited, 2003b).

Exposure to very fine PM emissions ($\text{PM}_{2.5}$ i.e., particulate matter less than 2.5 micrometres in size) has been found to vary significantly by travel mode (Kingham et al., 2011). A New Zealand study on the impacts of vehicle-related $\text{PM}_{2.5}$ emissions, found an impact on mortality. The findings are summarised in Table 6 below (Fisher et al., 2002).

Table 6: Annual mortality estimates associated with PM (Fischer et al., 2002)⁹

Location	Total mortality	Vehicle-related mortality
Auckland	436	253
Wellington	79	56
Christchurch	182	41
Dunedin	48	6
Rest of North Island	133	21
Rest of South Island	80	19
Total New Zealand¹⁰	970	399

Whilst the study had a number of limitations in terms of input data reliability, it is clear that vehicle-related PM_{2.5} emissions are causing health effects in urban areas. A more recent study by Kuschel et al. (2012) into overall mortality from PM₁₀ emissions suggests a higher annual mortality rate of 1,175 deaths per year. The proportion of transport related deaths was not separately considered, however if the proportion has remained similar to that in Table 6 then the total mortality associated with transport related PM₁₀ emissions may be in the order of 482 deaths per year.

Benzene is an aromatic hydrocarbon and vehicles are one of the known sources. Benzene is a known carcinogen. Long term exposure causes harmful effects on bone marrow, contributing to leukaemia, and a decrease in red blood cells leading to anaemia. Short term exposure can cause drowsiness, dizziness, unconsciousness, and death. New Zealand ambient air quality guideline levels are 3.6 $\mu\text{g}/\text{m}^3$ (annual average). There is however no exposure threshold below which there is no risk. Although ambient levels are met in most New Zealand urban areas, even quantities below these levels have some effect (Environet Limited, 2003a).

In terms of the potential effects on air pollution from reducing urban speeds, this primarily relates to the effect of reduced speeds on vehicle emissions and mode shift (reducing the

⁹ Based on a 4.3% increase in mortality, in population over 30, per 10 $\mu\text{g}/\text{m}^3$ increase in annual average PM_{2.5} concentrations above 7.5 $\mu\text{g}/\text{m}^3$.

¹⁰ Some differences in the total occur as a result of rounding in calculations.

amount of vehicle travel also reduces emissions). These two factors have been considered in detail in section 3.4.3. The overall conclusion is that reducing urban speeds is not likely to have any noticeable effect on vehicle emissions or mode shift. Research however indicates that there is potential for reduced urban speeds to reduce localised NO_x and PM emissions by small amounts. Further studies are however needed to conclusively determine these relationships. However even small reductions (or increases) in key air pollution emissions could have noticeable health effects. This is particularly so in respect to certain types of emissions which are known to be particularly harmful (such as PM and NO_x) (Genter et al., 2008).

Whilst there may be potential for reduced urban speeds to reduce air pollution and therefore achieve health benefits, there is insufficient research to conclusively determine this and results are likely to be location specific (depending on factors such as existing congestion, makeup of vehicle fleet and driver behaviour).

In addition to effects of air pollution from vehicle speeds, it is estimated that a 5% mode shift from light vehicles to cycling would lead to around 5.6 fewer deaths per year from local air pollution. It is noted that reduced mortality from air pollution, may actually be understated in this estimate as only the benefits to adults (18 years plus) were considered in the study (Lindsay et al., 2011).

3.4.4.2 Physical activity

Active transport requires use of large muscle groups and should be viewed as a worthy method to accumulating physical activity (Genter et al., 2008).

The Economic Evaluation Manual (New Zealand Transport Agency, 2010) values the health benefits from new pedestrians at 40 cents per kilometre, and new and existing cyclists at 16 cents per kilometre. This is despite research undertaken by BECA (2007) that concluded the benefits were actually around 80 cents per kilometer for walking, and 40 cents per kilometer for cycling (with a cap of \$1,000 per year per user). This was based on the willingness-to-pay for disability adjusted life years (DALYs), resource cost for the health sector, and lost output resource costs (Genter et al., 2008).

Genter et al. (2008) concluded that the health-related benefits of walking and cycling are around \$3.53-5.01 per kilometer for walking, and \$1.77-2.51 per kilometer for cycling. They also note that half these benefits should apply for existing pedestrians and cyclists, because without measures to contribute to walking and cycling, levels tend to decrease over time.

In terms of the health benefits for walking and cycling there is growing evidence of a reduction in risk of numerous chronic conditions due to physical activity, for example, a 55% risk reduction for all mortality (Bijnen et al., 1999; Erikssen et al., 1998) and 20-35% for cardiovascular disease (Macera et al., 2003). Regular physical activity also appears to provide a preventative and therapeutic effect on a range of mental health illnesses. Further specific evidence identifies a lower risk of cardiovascular disease, certain cancers, and obesity from uptake of physical activity through active transport. These are all significant health issues in New Zealand. In 2001 a lack of physical activity was the second leading risk factor of disability adjusted life years (7% of all DALYs) (Genter et al., 2008).

There is also evidence to suggest a correlation between choice of travel mode and stress levels. Several studies indicate that private car commuters had elevated stress levels, when compared to base line stress levels and people commuting via other modes (Genter et al., 2008).

It is estimated that a 5% mode shift from light vehicles to cycling would lead to 116 less deaths per year as a result of physical activity (Lindsay et al., 2011).

It is clear that increased physical activity from active travel can have public health benefits. Such benefits would only eventuate from reducing speeds if this resulted in mode shift or otherwise increased physical activity (for example, increased hours of active play for children).

3.4.4.3 Noise

Noise can also affect public health. The impact of noise varies from mild annoyance to significant health effects. High noise exposure can create stress-type responses, night time noise can cause sleep disturbance, and other potential effects include speech interference, reduced work performance, and impaired learning. Some research also indicates that long

term noise-induced stress can lead to hypertension and heart disease (Standards New Zealand, 2010b).

Road-traffic noise consists of mechanical noise (for example, engine and exhaust noise), rolling noise (tyre-road interaction) and aerodynamic noise (noise from rapid movement of a vehicle through air). The different characteristics of this sound determine the scale of effects this may have. The main causes of noise also vary with speed. At low speed, noise is predominantly caused by vehicle sources, for example, from the engine (cooling, transmission, exhaust). For speeds of more than approximately 50 km/h, tyre-road noise is the predominant source. The noise generated by tyres on the road surface, varies by the design of the tyre and the type of road surface, as well as in wet or dry conditions (Standards New Zealand, 2010b).

The level of audible noise depends on factors such as the composition of traffic, traffic conditions (including speed and flow), driver behaviour, type of road surface, grade of the road and surrounding topography, for example, elevation of the road (Standards New Zealand, 2010b).

Below 2,000 vehicles per day, noise effects typically relate to individual noise (e.g. a noisier than average vehicle) as a transient maximum sound level. Above this, however, combined traffic noise can be quantified by the time-average sound level ($L_{Aeq(t)}$) for a given time period (usually 24 hours) (Standards New Zealand, 2010b).

Reducing vehicle speed can reduce traffic noise, although significant changes are needed to have an appreciable impact (Standards New Zealand, 2010b).

For a single car passing a point at a constant speed, each 10 km/h increase in speed increases noise by 3 dBA. Two noises of the same magnitude added together produce an increase of 3 dBA (i.e., 60 dBA plus 60 dBA = 63 dBA) which is noticeable. Sound intensity is logarithmic therefore sound levels may not be an intuitive measure of noise. The nature or type of noise also influences the impact on amenity, for example, free-flowing vehicles are unlikely to cause disturbance however a vehicle accelerating heavily, during night time periods, may generate complaints (Dyson et al., 2001a).

It is also noted that if reduced urban speeds are, for example, achieved by narrowing carriageways, the additional land could be used for landscaping along the street. Landscaping can help reduce the effects of traffic noise. Hard surfaces reflect noise and therefore do not normally result in any reduction in noise levels (noise levels will typically decrease by around 3 dBA for every doubling in distance from the source). Loose dirt, grass, and bush, however provide a softer surface which can provide an additional reduction of 1.5 dBA such that for each doubling of distance (from noise sources such as tyres) noise levels can reduce by up to 4.5 dBA (Standards New Zealand, 2010b).

For comparison (in terms of the scale of effects) the difference in road surface can result in an 8 dBA change in road noise between the quietest surfaces (OGPA) and the noisiest (chip seal) (Standards New Zealand, 2010b).

In terms of valuing reductions in noise levels, the “Economic Evaluation Manual” (Standards New Zealand, 2010b) uses a monetised benefit of 1.2% of the market value of residential properties, per decibel reduction in noise.

In summary, lower speeds achieve lower levels of vehicle noise (Archer et al., 2008). A 10 km/h reduction in speed would be needed to have any audible change in noise levels. Given that reduced speeds can also smooth traffic flows and reduce acceleration and deceleration, this could also reduce noise effects. It is clear that reducing speed reduces noise however the extent to which this would be noticeable and have any health benefits is more difficult to determine.

Overall in respect to public health, reducing urban speeds is likely to have some small benefits over and above the benefits from reduced crashes. When the effects of reduced fatal and injury accidents are also considered the public health benefits could be significant.

3.4.5 Functional transport networks

Reducing urban speeds can potentially affect the functioning of transport networks in terms of travel times, delay, congestion and route choice. There is a general perception among drivers that increasing or reducing vehicle speed will have a corresponding and proportionate impact on travel time. Driving at a maximum of 30 km/h is slower than at a maximum of 50 km/h (4 minutes are needed to travel 2 km at 30 km/h, three minutes at 40 km/h, and approximately two and a half minutes at 50 km/h) (Dekoster & Schollaert, 1999). In the

urban environment the relationship between maximum speed and travel time is complicated by: intersections, congestion, giveaway rules, parking manoeuvres by other drivers, pedestrian crossings, double parking, and other factors which limit the number of opportunities to travel at maximum speeds. Such effects often have a greater influence on travel time than speed limits or maximum travel speed (Archer et al., 2008).

In highly congested conditions reducing the speed limit is unlikely to have any noticeable effect on travel time as most vehicles are travelling well below the speed limit already (due to congestion). Not surprisingly in uncongested urban conditions, reducing speed limits may increase travel time, although not proportionately. Some studies also show, that under moderately congested conditions (vehicles periodically able to travel at or close to the speed limit), reducing the speed limit can actually reduce overall travel time, by allowing a more constant flow of traffic. This occurs because travelling slower between traffic controls results in less build-up of queues and less time spent accelerating and decelerating (Archer et al., 2008).

Archer et al. (2008) cited a study by Haworth et al. (2001) that showed that a 5 km/h reduction in travel speed, in urban areas of Australia, would result in an average increase in travel time of 10 seconds per trip. They also found that a 10 km/h reduction would result in an average increase of less than 26 seconds per trip. Aggressive driving did not result in noticeable time savings (in one example aggressive driving in motorway conditions achieved only a 1 minute travel time saving for a 44 km journey).

The “Economic Evaluation Manual” (New Zealand Transport Agency, 2010) suggests a travel time value of \$16.23 per hour for all roads except arterial roads and roads with over 7,000 vehicles per day where a value of \$16.27 per hour applies. There is however a divide in the literature on how to value small changes in travel times. This centres around an argument that very small travel times are not useable by the individual i.e., that say a one to two minute reduction in travel time would not be used for other productive purposes, particularly given the potential trip variability (i.e., if they have to allow 5-10 minutes for potential congestion) (Austroads, 2011).

O’Fallon and Wallis (2012) recently found that around 40% of commuters, in New Zealand, actually enjoyed their commute time, as it provides some utility, for example, time to

transition or listen to music. The assumption that time spent travelling has no value is therefore questioned. Particularly, the research identified a core of commuters who were clear that they desired a minimum commute time. For such commuters travel time savings below this threshold may be incorrectly counted as benefits when their actual value might be zero or even negative (O’Fallon & Wallis, 2012). This would also potentially suggest that for some commuters small increases in travel time may not be seen as a dis-benefit and may actually even have some positive value.

The “Economic Evaluation Manual” (New Zealand Transport Agency, 2010) acknowledges that where a proposed change seeks to improve community liveability, by reducing traffic speeds, that it may be appropriate to remove the small travel time dis-benefits to motorised vehicles (as a sensitivity test). This essentially recognises that community liveability benefits may be equal to the dis-benefits of increased travel time, such that these factors may cancel each other out.

It is however noted that travel time is only one indicator of the functionality of a transport system. Road users value improvements in traffic congestion independently from travel time (New Zealand Transport Agency, 2010). Delay or travel time reliability, between optimal conditions and congested conditions, also affects the functioning of the transport system. Lack of traffic signal coordination and capacity, play an important role in explaining delay and travel time variability. In fact traffic signal coordination can be used to moderate traffic speeds and create a smoother traffic profile moderating congestion and variability in travel times (Archer et al., 2008).

A mode-shift from private vehicles to walking, cycling, and / or public transport, could however reduce total vehicle travel and therefore contribute to reducing congestion. Estimates of the average congestion cost saving for Auckland are around NZ\$1.19 per vehicle kilometre of travel reduced and around NZ \$0.91 in Wellington (figures are adjusted for induced traffic) (Aftabuzzaman et al., 2010). A 5% mode shift could therefore save around 223 million kilometres of travel (Lindsay et al., 2011). Assuming that the cost saving for Wellington is the closest to the average figure for New Zealand and that most mode shift to walking and cycling would occur in other urban areas, a total congestion relief benefit of around \$203 million could occur from a 5% mode-shift. As outlined above, there is however

insufficient information available to determine whether reducing urban speeds would achieve mode-shift.

Overall, reducing urban speeds may have some dis-benefits in terms of increased travel time. The value of this time to individual drivers is however likely to be small and in residential areas may be off-set by improved liveability.

3.4.6 Economic development

Reducing urban speeds can also affect economic development. Some case studies reviewed by O’Fallon and Sullivan (2011) indicated pedestrianised and slow-zone treated shopping areas resulted in increased pedestrian traffic. This may relate in part to the street becoming a destination rather than solely a corridor. Associated effects included decreases in shop vacancies and increases in rents. Some of the studies reviewed suggested between 40 and 70 percent of businesses felt that the changes had a positive effect on their business.

It must also be noted that some studies have shown an increase in work productivity associated with physical activity. Benefits include reduced absenteeism (improved health) and improved work performance. If reducing urban speeds can encourage mode shift or increased physical exercise for recreation, this could also have some positive influences on work place productivity. Unless a considerable change occurred the net benefits would be likely be small (Genter et al., 2008).

Reducing travel speeds can however also potentially increase journey time. In urban areas the increase in travel time is usually small, however this can still have some economic costs, for example, vehicle operating costs (VOC). Vehicle operating costs include (New Zealand Transport Agency, 2010):

- Running costs (fuel, repairs and maintenance etc.);
- Additional running costs due to the road surface, traffic congestion or significant speed fluctuations from the cruise speed; and,
- Additional fuel costs due to being stopped, such as queuing at traffic signals.

As outlined above, reducing urban speeds can reduce fluctuations from the cruise speed and create smoother traffic flows with less time stopped in queues or at signals. Fuel consumption varies significantly with different driving patterns. A trial undertaken in

Melbourne found that a large passenger vehicle driven smoothly achieved better fuel economy than a small car driven aggressively (and there was no significant change in journey time) (Archer et al., 2008).

Other operating costs, such as tyre wear and mechanical wear, tend to increase with increasing speed, and are most significant for truck fleets. Generally in terms of changes in speed, changes in fuel consumption costs outweigh changes in operating costs. Small changes in vehicle operating costs, other than fuel, are less likely to be noticed by private drivers and are unlikely to affect speed choice (Archer et al., 2008).

Whilst vehicle operating costs are unlikely to noticeably change, the additional time to transport goods could also have a small impact on business efficiency. Road transport accounts for around 1.3 percent of total costs for industries in New Zealand (Infometrics, 2003). Given that the increase in travel times is typically small this is unlikely to have any noticeable effect on business costs, particularly in the context of existing variability in travel times due to congestion, crashes, and the like.

There are also social costs (to the economy as a whole) associated with road crashes. The total social cost of motor vehicle injury crashes in New Zealand in 2011 was estimated to be around \$3.54 billion. The key factors contributing to this cost were loss of life or life quality (around 91%), property damage (around 5%) and other costs including medical, legal and loss of output (temporary incapacitation) (Ministry of Transport, 2011c). Given reducing urban speeds can reduce crash rates and severity, this would be expected to reduce social costs associated with crashes. Crashes in urban areas represented approximately 60% of all injury crashes (Ministry of Transport, 2011d). This suggests that around \$2 billion of the total \$3.54 billion may be associated with crashes in urban areas.

From section 3.4.1 above, if a 5% reduction in speed was applied to all urban areas of New Zealand, this could achieve a 10% reduction in urban accidents. This could result in a saving of around \$2 million in social costs associated with urban road crashes.

A number of benefit-cost analyses have been undertaken for reducing urban speeds. Significant problems occur in relation to quantifying safety benefits (putting dollar values on human lives) and determining the costs of very small travel time increases, which may not be useable / noticeable to the individual. Regardless a study of reducing urban speeds in

Australia by five percent, suggested a net benefit of around \$14-34 million (AUD) per year (Haworth et al., 2001). Another study considering reducing speeds in Melbourne by 10 km/h across all roads, would result in economic benefits of more than \$60 million (AUD), despite economic losses due to travel time (Archer et al., 2008).

Overall, in terms of economic development, any increase in costs associated with travel times is likely to be balanced or outweighed by decreased social costs (health benefits) and increased local business sales.

3.4.7 Integrated urban form

Reducing urban speeds can impact on urban form in terms of the space required for roads and improving liveability. Some physical speed reduction measures, for example, road closures, kerb build outs, and central medians, and some visual cues, such as narrowing the carriageway, can reduce the space required for roads.

In new subdivisions, road design for lower speeds enables narrower roads to be provided, reducing the road corridor and total area of land required for roads. This in turn provides more space for housing and could contribute to increased housing densities. It is difficult to determine the ratio of land for transport to housing. That said even a 1.5 m reduction in the road corridor width, for a distance of 300 m, would equate to an additional 450 m² of land. This equates to the minimum lot size, required for a standard suburban residential site, in Christchurch (Christchurch City Council, 2005). Whilst this may not be significant in the context of reducing urban sprawl this certainly enables more efficient use of land.

In terms of existing roads, this can result in additional space for street trees and other plantings, within the road corridor. Provision of vegetation and plant materials in a street contributes to the visual amenity of the street and the level of comfort and satisfaction for users. This therefore provides a secondary benefit, in terms of integrated urban form, contributing to liveability as well as improving ecological diversity, and reducing air pollution, which therefore makes more efficient use of the road corridor (Moudon & Appleyard, 1987).

Reducing speeds can also ensure that the road is more suitable for non-transport related uses of the road corridor as a public space and therefore that the speed matches the needs of the

adjoining land use, whether that be outdoor seating for a café or space for children to play (Moudon & Appleyard, 1987).

A study of three street types in Basel, Switzerland, considered a 50 km/h street, 30 km/h street and three encounter zones (20 km/h pedestrian priority / home zones). The study included how residents used the streets and their perceptions of them. Some of the uses and questions on perception are shown in Figure 9 and Figure 10 (Sauter & Huettenmoser, 2008).

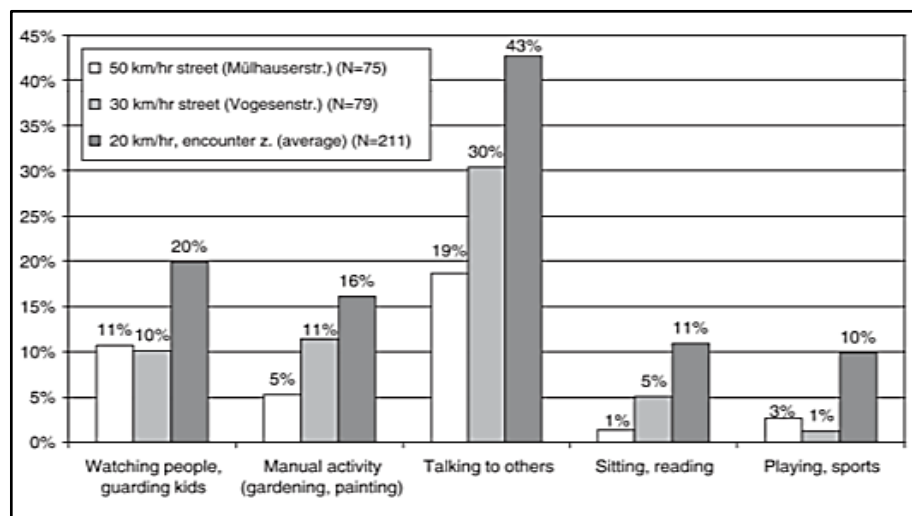


Figure 9: Activities undertaken in street (Sauter & Huettenmoser, 2008)

Figure 9 shows that people are more likely to undertake sports, reading, talking, manual activity, and people-watching, on 20 km/h streets than on 30 or 50 km/h streets. Manual activity, talking to others and reading were also more likely to be undertaken on 30 km/h streets than 50 km/h streets. There was little difference between 30 km/h and 50 km/h streets in terms of sport and people-watching (Sauter & Huettenmoser, 2008).

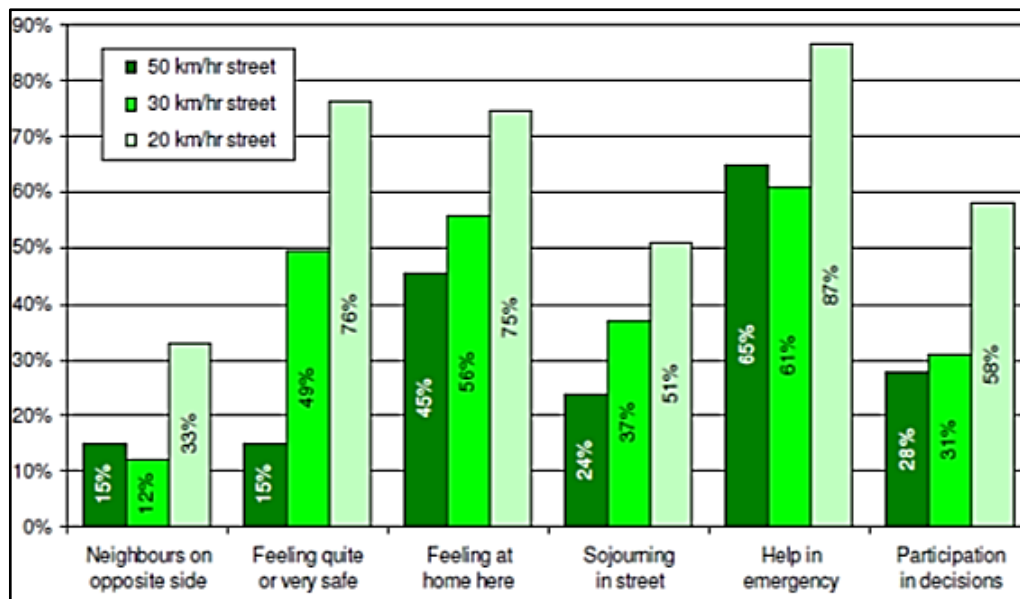


Figure 10: Residents opinions of different streets (Sauter & Huettenmoser, 2008)

The study identifies that residents on 20 km/h streets are more likely to feel at home on the street, and consider it close to their ideal street, and / or that it provides everything they need to be happy. Residents on 30 km/h streets were also more likely to feel at home than those on 50 km/h streets (Sauter & Huettenmoser, 2008).

Whilst the results of the survey showed that lower speed streets were typically more livable this cannot be considered to relate solely to the speed of traffic. The streets surveyed also had different traffic volumes (around 3,000 vehicles per day on the 50 km/h, 1,400 vehicles per day on the 30 km/h and around 250 vehicles per day on the 20 km/h) and different street scapes (for example, level of parking provision, amount of green space). It is anticipated that all of these factors contribute to the liveability of a street (Sauter & Huettenmoser, 2008).

Quantifying the benefits from improved liveability, or reduced use of land for roads, is difficult. The “Economic Evaluation Manual” (New Zealand Transport Agency, 2010) acknowledges that where a proposed change seeks to improve community liveability by reducing traffic speeds, that it may be appropriate to remove the small travel time dis-benefits to motorised vehicles (as a sensitivity test). This essentially recognises that community liveability benefits may occur and are likely to be of a similar value to the dis-benefits of increased travel time such that these factors may cancel each other out.

Overall, it is considered that, whilst difficult to define or quantify, reducing urban speeds does contribute to more integrated urban form in a positive way.

3.5 Summary of effectiveness of reducing urban speeds

The likely effectiveness of reducing urban speeds, to achieve sustainable land transport outcomes includes consideration of the effects on: safety, accessibility, environmental sustainability, public health, functional transport networks, economic development and integrated urban form.

It is evident from the discussions above, that there is a clear and reasonably consistent relationship between reducing urban speeds and improving safety, particularly in terms of reducing crash severity, and reducing the number of crashes involving pedestrians and cyclists.

Lower speeds contribute to making a road more pedestrian and cycle friendly and may contribute to preventing crime, therefore improving accessibility for some members of the community.

The key factors likely to affect environmental sustainability are: vehicle emissions, fuel / energy use, and mode shift. Research suggests that there is not likely to be any noticeable change to the level of vehicle emissions or fuel use. Whilst lower speeds may encourage mode shift there is insufficient evidence to conclusively determine this.

In terms of public health, there is good evidence that reducing urban speeds reduces noise. Although any changes in vehicle emissions are not likely to be noticeable in terms of air pollution, even small, localised reductions in some emissions such as particulate matter and nitrogen oxides (NO and NO₂), may have health benefits. Further public health benefits could also accrue, from increased physical exercise, if mode-shift towards walking and cycling, or increased play / recreational exercise, occur. Overall, although difficult to quantify, reducing urban speeds is likely to contribute to sustainable land transport to some (small) degree.

In terms of functional transport networks, there is reasonable evidence that whilst travel times will increase, the increase is not equal to the change in speed and is likely to be small. In residential areas the effects of increased travel time are likely to be offset by other

benefits, such as improved liveability. Further there is some indication that lower speeds may actually create smoother traffic flows and reduce congestion.

In terms of economic development there are unlikely to be any noticeable effects in terms of fuel use or vehicle operating costs. There may however be a small increase in the cost of goods due to increased travel time, but this is unlikely to be noticeable in terms of the overall cost. Potentially reducing speeds can increase foot traffic past and support local businesses. Reductions in crash rates can also reduce the social costs of accidents. Comparisons of the costs and benefits suggest that the benefits are likely to outweigh the costs.

Improved livability and more efficient use of space / re-use of existing space, may contribute to achieving improvements in integrated urban form.

From the literature review it is considered that reducing urban speeds will effectively contribute to achieving sustainable land transport outcomes in terms of safety, will likely contribute to public health, accessibility, integrated urban form, environmental sustainability, and economic development. The impact of increased travel times on functional transport networks is likely to result in some dis-benefits, however these are not likely to be significant in the context of other (for example safety) benefits.

4 Case Studies

4.1 *Selection of case studies*

This section considers three different case studies where reduced urban speeds have been implemented. The first case study is Graz, Austria, where reduced speed limits have been applied to all local (non-priority) roads within the city. The second case study is Unley, Australia, where reduced urban speeds have been applied to all local roads in Unley (a suburb of Adelaide). The third case study is Hamilton, New Zealand, where 40 km/h speed limits have been installed in residential streets.

These three case studies represent speed reductions at varying scales, from the city wide approach used in Graz to residential streets in Hamilton. The effects associated with the Graz and Unley speed limit reductions have been monitored and have been in place long enough for a reasonable analysis of the results. The Hamilton case study provides a New Zealand example and whilst few results are available, provides information on the implementation process and opinions of the New Zealand public.

4.2 *Graz, Austria*

Graz is a city in Austria with around 258,000 inhabitants, covering around 127 km², with around 70,000 daily commuters. The road network spans some 1,056 km with approximately 55 km of motorways, 194 km of priority streets, and around 800 km of non-priority streets (Ablasser, 2011). 80% of traffic in Graz is on priority (arterial) roads (Fischer, 2010).

Graz has 6 tram lines, 37 bus routes, a 116 km bicycle network (Ablasser, 2011) and a strong policy on achieving “gentle mobility” (Wernsperger & Sammer, 1995).

Graz was the first city in Europe to adopt a 30 km/h speed limit for all non-priority streets. The existing 50 km/h speed limit was retained for priority roads. The 30 km/h speed limit covers around 80% of the whole city (ELTIS, 2011a).

The 30 km/h limit was initially introduced as a two year trial. The trial was scientifically and comprehensively investigated by (Wernsperger & Sammer, 1995):

- Institute for Highway Engineering and Transportations, Technical University of Graz (who coordinated the investigation, considered changes to mode of transport and route choice, as well as traffic noise and behaviour).
- Institute for Internal Combustion Engines and Thermodynamics, Technical University of Graz (who considered exhaust emissions).
- Graz Institute for Traffic Safety (who investigated speed measurements and traffic safety).

This comprehensive recording and analysis provides a robust basis for considering the efficiency and effectiveness, of the 30 km/h speed limit in Graz.

4.2.1 Approach / implementation

The very first use of 30 km/h limits in Graz occurred on two residential areas with a diameter of approximately one kilometre. They included limited speed management measures, such as entry gate treatments at the start of the zone and a limited number of road humps or narrowings within the zones, as well as road surface markings, street signs and a change in priority rules for the area. Some public relations work was also undertaken (Wernsperger & Sammer, 1995).

These zones were successful and by 1991 more than 80, 30 km/h zones had been requested by citizens groups. It was recognised however that even with minimal treatments in these zones, the cost would be prohibitive for the city's budget. It would also take a considerable amount of time to implement on a zone by zone basis (several decades) (Wernsperger & Sammer, 1995).

The application of the 30 km/h limit, on all non-priority roads, was considered to be easy to understand, fair, immediately active, economical and better for the cityscape (Fischer, 2010).

Given that a 30 km/h speed limit had not been used at this scale in a comparative city, the reduced speed limit was implemented on a two year trial basis (from September 1992-August 1994). Following monitoring and analysis of the results and public opinion, it was decided in July 1994 to continue with the 30 km/h speed limit for all non-priority roads (Wernsperger & Sammer, 1995).

Implementation included installation of traffic signs at the outskirts of the city, informing drivers of the 30 km/h limit on all non-priority streets and 50 km/h on priority streets. All priority streets were marked with “priority street” signs and multi-lingual information boards were used at the main approach roads. Reminder 30 km/h pictograms were also used on the entrance to side streets (Wernsperger & Sammer, 1995).

Implementation included a vast (public) awareness campaign including political / decision makers, journalists, and the general public. During the introductory phase (2 months) there was also extensive information provided via the media, boards and banners (ELTIS, 2011a; Wernsperger & Sammer, 1995).

Part of this campaign included increasing motorists’ awareness of the risks to others by driving at 50 km/h in local streets and also the small amount of time they would lose. The introduction of the 30 km/h speed limit was implemented to coincide with the school term recommencing, in order to stress the safety aspects (Dekoster & Schollaert, 1999).

The two year trial started in September 1992, but was not unanimously supported, on-going contra-campaigns occurred prior to implementation. Opponents sought a public opinion poll however the former vice mayor of Graz argued that it wouldn’t be easy for people to vote on such a measure, before they had seen the effects (and thus the two year trial). Whilst people were very much against the measure before it was implemented a clear majority voted for 30 km/h speed limit after the two year trial (ELTIS, 2011a). Following the two year trial, the 30 km/h limit for non-priority roads was permanently adopted in 1994.

4.2.1.1 Costs

Costs for the 30 km/h limit include both start-up and on-going running costs. Start-up costs included both preparing for the changes (for example, public awareness campaigns) and implementing the changes (for example, provision of signs). Running costs include ongoing campaigns and maintenance. Some basic startup and running cost figures are summarised in Table 7 (Fischer, 2010).

Table 7: Costs of implementation and management of 30 km/h speed limit in Graz (Fischer, 2010)

Cost category	Cost (€)	Cost (NZD ¹¹) conversion
Start-up Costs		
Preparation (Scientific consulting)	145,000 (120,000)	~269,700 (~223,200)
(Campaigns)	(25,000)	(~46,500)
Introduction (Campaign)	240,000 (45,000)	~446,400 (~83,700)
(Signposting)	(100,000)	(~186,000)
(Marking)	(95,000)	(~176,700)
Startup Costs Total	385,000	~716,100
Running Costs (per year)		
Maintenance	~80,000	~148,800
Campaigns	~30,000	~55,800
Running Cost (yearly total)	~110,000	~204,600

The majority of the start-up costs are likely to be associated with the technical, practical and educational aspects (discussed above), that were undertaken during the implementation process.

Running costs are likely to involve ongoing awareness campaigns and replacement of signs and markings etc. It is assumed that enforcement costs are included within the maintenance category however this is not clear from the information available.

4.2.1.2 Enforcement

Monitoring and enforcement were an essential component to implementing the 30 km/h speed limit. Police were provided with additional laser guns to check speed, resulting in more intensive monitoring and enforcement. Some stationary radar devices were also used. Monitoring and enforcement were undertaken on both 30 km/h and 50 km/h streets. At the beginning of the trial, drivers slightly exceeding the 30 km/h speed limit were warned but

¹¹ Based on conversion rates at date of publication of cost figures (2010) of approximately 1.86 Euro to the New Zealand Dollar.

beyond this initial phase, speeding was a punishable offence (Wernsperger & Sammer, 1995).

In 2006, a private speed control company was contracted by the City of Graz to monitor and enforce the 30 km/h speed limits. This was however stopped, 3 years later, by the courts. Subsequent legislative changes now allow city (council) staff to be sub-contracted to the police to undertake speed limit enforcement (ELTIS, 2011b).

In 2006, the speed of 150,000 vehicles was measured (15,800 of these drove too fast). In 2010, 182,000 measurements were carried out and 14,460 car drivers were fined. 20% of the fines have to be forwarded to the national government of Austria. The rest (unlike in New Zealand) can be used by the City of Graz (ELTIS, 2011b).

The City (Council) of Graz also has 13 new devices that show drivers their current speed. The devices are moved around each month, among 130 specially prepared locations, in particularly sensitive areas (e.g. near schools). Evaluations show that automatic feedback helps to keep cars within the speed limit (Ablasser, 2002; Wernsperger & Sammer, 1995).

4.2.1.3 Change in speed

In order to identify changes in traffic speeds associated with the 30 km/h speed limit, speed measurements were undertaken on 78 places within the street network. Trained personnel used hand radars to record existing speeds three months before the first trial. They noted the type of vehicle (car, bus, truck), and whether the driver was travelling at free speed or in convoy. Measurements were taken over a two hour period during the day (between 7 am and 7 pm) and two night-time measurements were also made (Wernsperger & Sammer, 1995).

Comparisons of the mean (average) speed before and after the 30 km/h speed showed only a small reduction in mean speed. There was however a greater reduction in faster vehicles with the proportion of vehicles travelling at more than 50 km/h reduced from 7% to 3%. A third measurement series in March 1993 and another in 2002 showed smaller speed reductions, which could reflect the reduced public attention and faded 30 km/h pictograms on the streets (Wernsperger & Sammer, 1995). The mean and 85th percentile speeds are shown in Figure 11.

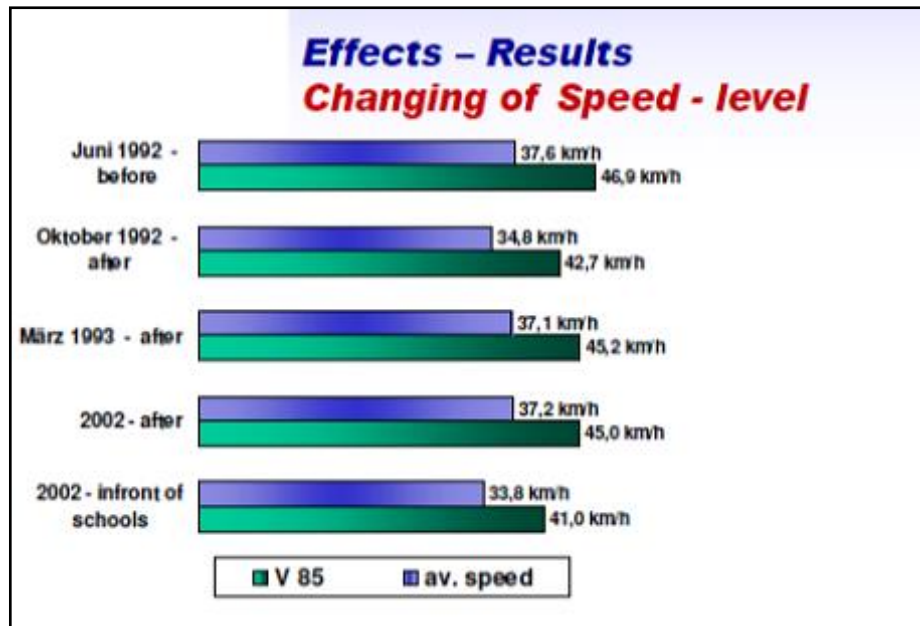


Figure 11: Graz changes in speed (Fischer, 2010)

Interestingly both the mean and 85th percentile speeds prior to implementation were below the existing 50 km/h speed limit. It is unclear why this is, but could relate to the existing geometry of roads (encouraging lower operating speeds) or congestion. It is assumed, given that the two initial 30 km/h zones required road narrowings and speed humps, that residential roads were not generally of a form which would encourage lower operating speeds, and congestion may therefore be a key factor.

The measurements undertaken in October 1992 (just after the 30 km/h limit was introduced) showed a 2.8 km/h reduction in mean speed and a 4.2 km/h reduction in 85th percentile speed. By March 1993 mean speeds had increased to almost the same as (only 0.5 km/h less than) mean speeds before the 30 km/h limit was introduced. The 85th percentile speed was however still 1.7 km/h less than the 85th percentile speed before the 30 km/h limit. Both the mean and 85th percentile speeds recorded in 2002 were very similar those recorded in 1993. It is therefore concluded that whilst a noticeable reduction in mean speeds was initially achieved, the sustained reduction was much less. Both the initial and sustained reduction in 85th percentile speeds was however greater than the change in mean speed.

4.2.1.4 Public Opinion

In terms of overall public support for the 30 km/h speed limit, telephone interviews were undertaken before the introduction of the trial period (June 1992), just after implementation (October 1992), 6 months after (March 1993), and 18 months after implementation. The interviews were conducted by specially trained students using the same form of questioning in each round of interviews. This data was compared to results from written surveys from 1985 and 1989. The results are shown in Figure 12 below

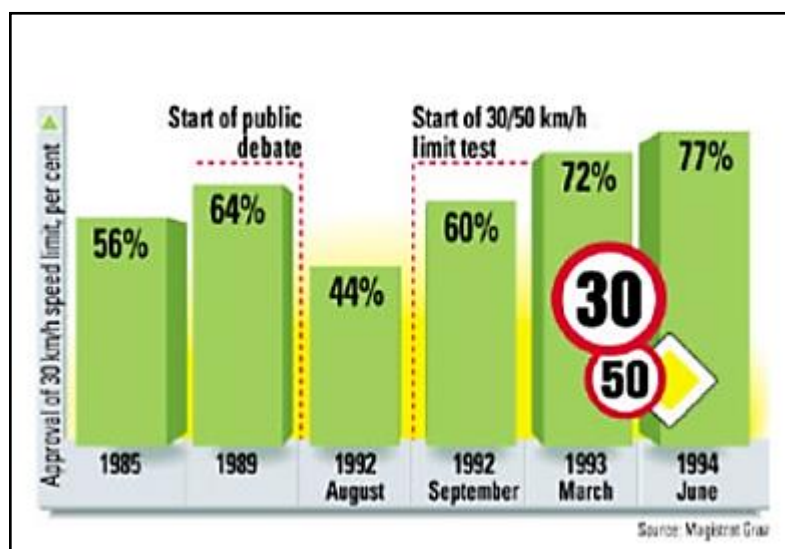


Figure 12: Approval of 30 km/h speed limit (Hoenig, 2000)

The surveys of public support indicate that whilst there was initial enthusiasm (64% support in 1989) this declined just before the trial. This decline may reflect public uncertainty about negative effects and a misunderstanding about the retention of the 50 km/h limit on priority streets (Wernsperger & Sammer, 1995).

The results show that just before the trial, the majority did not support the 30 km/h speed limit (only 44% support). 18 months after the speed limit had been introduced, 77% of the population supported¹² it (Wernsperger & Sammer, 1995).

¹² This increased steadily (60% in September 1992, 72% in March 1993 and 77% in June 1994).

Survey's by others suggest some differences in the level of support (Fischer, 2010) however indicate a similar pattern (as shown in Figure 13) of support declining prior to implementation but continuing to improve post implementation.

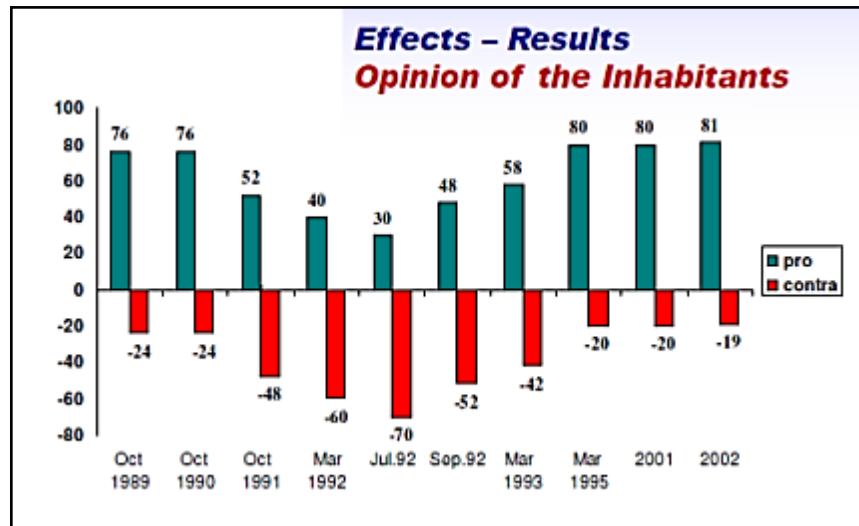


Figure 13: Public opinion of reduced speed limits in Graz (Fischer, 2010)

In terms of public expectations surrounding the 30 km/h speed limit, one of the key concerns prior to implementation was the effect on traffic congestion. Two-thirds of citizens believed that the 30 km/h speed limit would increase congestion. By June 1994 (after the 30 km/h limit had been introduced) only one-third felt that it had actually caused more traffic jams (Wernsperger & Sammer, 1995).

Before the start of the trial more than half (52%) of citizens felt that exhaust emissions would increase, this has now reduced to 24%. A large proportion (62%) thought that the 30 km/h speed limit would reduce the number of accidents, which actual results have confirmed and 71% now believe accidents have decreased (Wernsperger & Sammer, 1995).

One third of citizens also felt that noise levels would drop, but interestingly only in the fourth round of interviews (one and a half years later) did the number of people who felt less bothered by traffic noise reach 34% (Wernsperger & Sammer, 1995).

It can reasonably be concluded that the public over-estimated the potential negative consequences of the proposal and that many have come to realise this since the 30 km/h speed limit was introduced.

4.2.1.5 Political Influence

None of the literature reviewed specifically discusses political support and direction however it is evident that significant political support was critical to the implementation of the two year trial (given the majority of the public did not support the 30 km/h limit during the consultation phases). The city has a strong focus on total mobility and the 30 km/h limit was seen as complementary to this vision. It is unclear whether there has been any central government support, direction or guidance but legislative changes were made to enable council staff to be contracted to police for speed enforcement.

4.2.2 Outcomes of 30 km/h speed limit

The analysis of the impacts of the 30 km/h speed limit focused on safety, mode shift and route choice, vehicle emissions, and noise.

4.2.2.1 Safety

Consideration of traffic safety focused on injury accidents between 1 September 1991 and 31 August 1993. The study drew on official accident data statistics and records of speed at accident locations, before and after the implementation of the 30 km/h speed limit (Wernsperger & Sammer, 1995).

Comparison of September 1991-August 1992 (the year before the 30 km/h speed limit), with the year after the 30 km/h speed limit was implemented, identified the following results (Wernsperger & Sammer, 1995):

- A 24% reduction in serious injury accidents and a 12% reduction in accidents with slight injury to persons;
- A 17% reduction in accidents involving pedestrians;
- A 27% reduction in accidents at intersections of two roads where the speed limit was decreased to 30 km/h;
- A 22% reduction in accidents at intersections where the speed limit on the roads remained at 50 km/h; and,
- An 11% reduction in mid-block accidents on 50 km/h streets and no statistically significant change (5% increase) in mid-block accidents on 30 km/h streets.

Whilst the analysis period was not long, because the trail covered the whole city, the results were statistically significant. In addition, as a control, extra police speed enforcement was also undertaken in other cities in Austria where there were some smaller reductions in accident rates (4.5-9.4%) but also some increases in accidents (3.1-11.3%) (Wernsperger & Sammer, 1995).

Overall, the total number of accidents, as well as injury or fatal car-accidents, declined significantly, as shown in Figure 14.

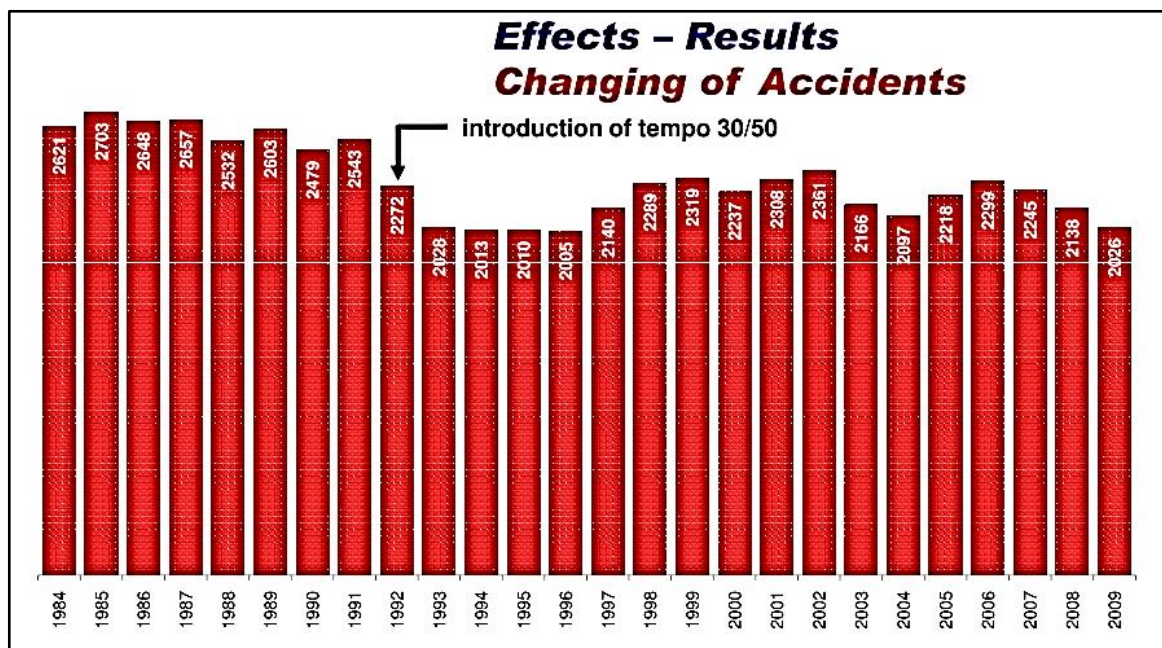


Figure 14: Changes in accidents Graz (Fischer, 2010)

Comparing the average number of accidents in the previous 5 years to the average number during the 5 years after the implementation showed a drop from 2,563 to 2,039 accidents (PIMMS, 2006). Beyond this period however, accident numbers shown in Figure 14 have fluctuated. The numbers still appear to be lower than the fluctuating levels prior to 1992. Although causation cannot be concluded, it is interesting to note the steady decrease in accidents since 2006. This may reflect greater speed enforcement associated with the contracting of a private speed control company in 2006 and speed monitoring by city staff on behalf of police commencing in 2009. No mean or average speed measurements were available beyond 2002 however it would be interesting to determine whether the change in enforcement since 2006 has had an impact on mean and 85th percentile speeds.

Lower speeds particularly improve road safety conditions for cyclists and pedestrians. The number of accidents with cyclists has decreased, despite cycle use increasing (PIMMS, 2006). This is shown in Figure 15.

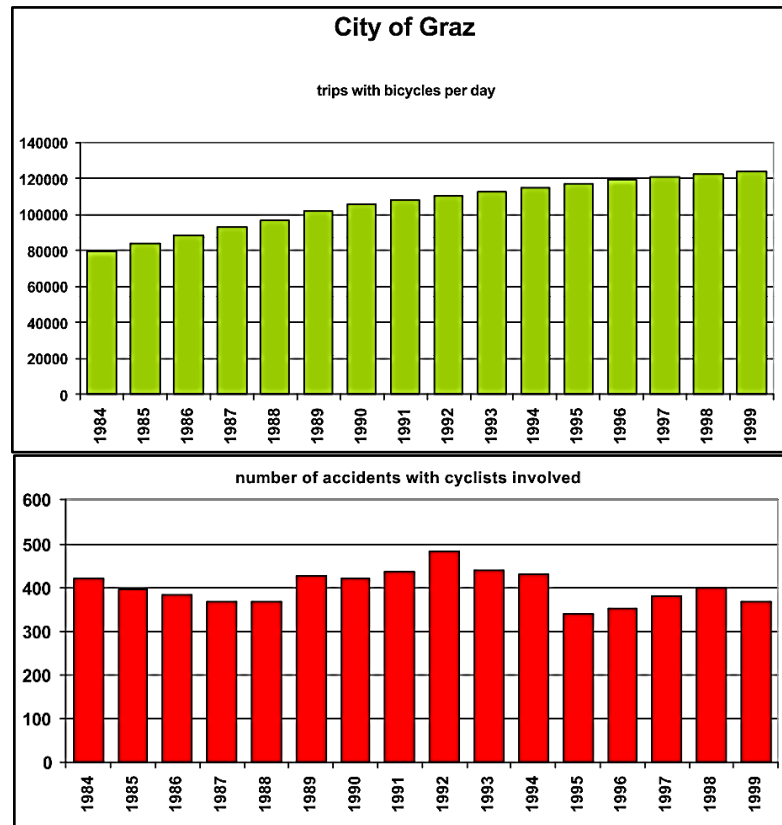


Figure 15: Change in cyclist and cycle crash numbers (Hoenig, 2000)

It can be reasonably concluded from the information above that the 30 km/h limit has improved road safety in Graz.

4.2.2.1 Mode shift and route choice

The travel behaviour of over 10,000 households in Graz, on a normal working day, was considered and 230 detailed interviews were undertaken from 100 households. These interviews asked citizens to map out the routes and modes used before and after the 30 km/h speed limit (Wernsperger & Sammer, 1995).

700 trips were described in these interviews however none indicated a change in mode of transport (Wernsperger & Sammer, 1995). Route choice also changed very little, with only 1.5% of the trips using a different route after the 30 km/h speed limit was introduced (Fischer, 2010). Although traffic count data has not been outlined, it appears that concern

that the 30 km/h speed limits would lead to increased traffic on priority streets and result in congestion, did not eventuate. No information was provided on the traffic volume effects on 30 km/h streets (Wernsperger & Sammer, 1995).

4.2.2.2 Vehicle emissions and fuel consumption

170 test drives (totalling over 2,000 km) along roads in Graz were used to measure the speed, distance, and time of the journey, such that the emissions from each individual vehicle, at speeds of 50 km/h and 30 km/h, could be investigated. This included the difference in emissions at different parts of the journey, for example, at intersections. The test drives were undertaken in three 'typical' areas within Graz, such that the results could be projected for the rest of Graz. The method used also made it possible to take into account other factors, such the percentage of cars with catalytic converters and diesel engines (Wernsperger & Sammer, 1995).

The results from the test drives indicated that changes differ between the types of vehicle emissions. Lower average speeds result in higher rates of carbon monoxide emissions. Hydrocarbon emissions are instead influenced by road user behaviour. This means that a whole range of differing exhaust emission quantities can be produced at a particular average speed (Wernsperger & Sammer, 1995).

No connection between average speed and nitrogen dioxide emissions was found (Wernsperger & Sammer, 1995). Road user behaviour has considerable influence and the steadier the driver drives, the lower the amount of emissions (Wernsperger & Sammer, 1995).

Following wider considerations using the information from the test drives and the mileage for the whole city, it was concluded that the largest proportion of vehicle emissions come from priority roads. Given the 50 km/h speed limit was retained on these roads and that there was no change in mode or significant change in route choice, there was no noticeable difference in the level of emissions on these roads (Wernsperger & Sammer, 1995).

Streets where the speed limit was reduced to 30 km/h account for only 5-8% of all gases emitted. The changes on those streets were positive and negative, depending on the emission considered (3.8% increase in CO, 0.5% increase in HC). The only really significant change

identified was a 24% reduction in nitrogen dioxide¹³ emissions, assumingly due to steadier driving conditions. When applied to the whole city, this equated to a 1.9% reduction in nitrogen dioxide (Wernsperger & Sammer, 1995; Fischer, 2010). This is shown in Figure 16.

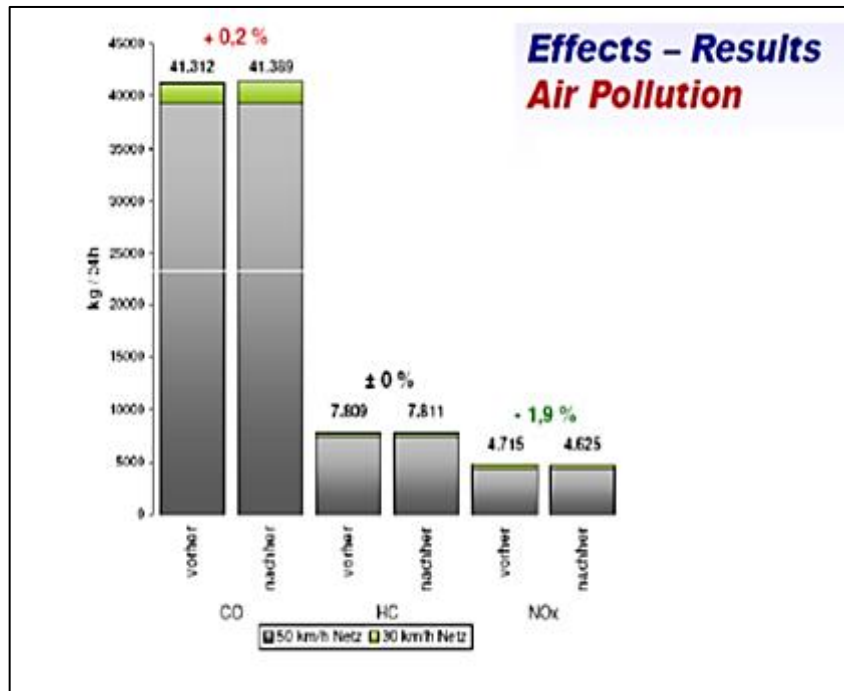


Figure 16: Air pollution effects –Graz reduced speed limits (Fischer, 2010)

Overall, it was concluded that the level of exhaust emissions had hardly changed, with no recognisable increases and a very slight reduction in nitrogen dioxide emissions (Wernsperger & Sammer, 1995).

Less detailed information was provided regarding fuel consumption. The same test drives were used to determine fuel consumption, and it was concluded that, fuel consumption was not affected by the 30 km/h limit (Wernsperger & Sammer, 1995; Fischer, 2010).

4.2.2.3 Noise

Noise was measured at 11 locations along roads in Graz (on the pavement one metre from the kerb) before and after the 30 km/h speed limit. Traffic counts and average speed were

¹³ Nitrogen oxide is emitted by vehicles and oxidised resulting in nitrogen dioxide.

also recorded during the measurements, to allow the sound level to be calibrated between the before and after studies and ensure the sound levels recorded were comparable (Wernsperger & Sammer, 1995).

At 9 of the 11 locations there was less traffic. At the other two measurement locations, the energy equivalent continuous sound level (L_{eq}) and the peak level (L_{01}) were measured (Wernsperger & Sammer, 1995).

The results at these two sites showed that noise reduced by 0.9 -1.9 decibel (L_{eq}). On the basis that one dB represents a change in noise that is just perceptible, the noise environment at one of the sites was considered to have improved. The peak noise levels at the two sites reduced by 0.9-2.5 dB, which suggests a reduction in the subjective disturbance from traffic noise. These reductions in noise reflect both reductions in speed and less acceleration (due to drivers driving at a steadier speed). Overall it was concluded that noise pollution has slightly decreased (Wernsperger & Sammer, 1995).

4.2.3 Summary of effects

In summary, whilst a noticeable reduction in means speeds was initially achieved, the sustained reduction was much less. Both the initial and sustained reductions in 85th percentile speeds were greater than the change in mean speed. It is however suspected that renewed enforcement efforts since 2006 may be resulting in speed reductions again.

The speed reductions resulted in the number of injured persons and the severity of accidents within the whole city dropping and an overall improvement in safety particularly for cyclists.

Mode choice, driver route selection, vehicle emissions and fuel consumption have not changed noticeably. It was also concluded that there was a small reduction in noise pollution.

It is considered that the overall effects of the 30 km/h speed limit on sustainable land transport was positive however the monitoring has not considered potential changes to travel times.

4.3 Unley, Adelaide, Australia

The City of Unley (Unley) spans between two and five kilometres south of the Adelaide Central Business District (CBD). The north-south arterials and collector roads through Unley

barely cope with peak periods and residents believe that much of this traffic diverts to residential streets (Dyson et al., 2001a).

In Australia the responsibility for setting speed limits lies with individual states and territories (Woolley et al., 2002). Local Area Traffic Management (LATM) has been used in Unley since the mid-1970's and in 1991 a trial 40 km/h zone (less than 1 km wide) on a north – south axis was implemented. In 1999 the 40 km/h speed limit was extended to all local roads across Unley (Dyson et al., 2001a).

In 1999, when the Council implemented the 40 km/h speed limit on all local roads, the general urban speed limit was 60 km/h throughout Australia (Dyson & Woolley, 2003). In March 2003, the Government introduced a 50 km/h Default Urban Speed Limit (DUSL) such that the 11 collector roads through Unley now have a 50 km/h speed limit. A 60 km/h speed limit remains only on the three arterial roads through Unley (Dyson et al., 2004).

The first study (1999-2000) seeking to consider the effectiveness of the new speed limit sought to analyse and interpret data on both the 40 km/h local roads and remaining 60 km/h collector and arterial roads, before and after the speed limit change. The study compared the results after implementation with historical data from 1998, for 112 midblock sites (73 on streets with reduced speed limits in 1999, 13 where the speed limit was reduced in 1992, and 26 on streets where the speed limit had not been reduced) (Dyson et al., 2001a).

The key aspects considered within this study were: traffic speeds and volumes, on-going community support, perceptions of improved amenity, and reductions in crash incidence (Dyson et al., 2001a).

Further studies have also been undertaken in 2001 (using traffic monitoring only), 2002 (into crashes and enforcement) and another comprehensive review in late 2003, considering similar parameters (and also considering the impact of the 50 km/h limit on collector roads) (Dyson et al., 2004).

This comprehensive recording and analysis of the 40 km/h speed limit in Unley, enables the effects of the 40 km/h limit to be considered.

4.3.1 Approach / implementation

The 40 km/h speed limit was initially introduced in 1991 as a trial 40 km/h zone. The trial area covered a north–south axis and was less than one kilometre wide and bounded by an arterial and collector road.

Traffic monitoring and surveys of residents' opinions following the trial determined that a 40 km/h speed limit for local roads was feasible. In 1999, the 40 km/h speed limit was therefore extended to all local roads across Unley (Dyson et al., 2001a).

Figure 17 shows the local roads, within the approximately 15 km² area of Unley, on which the 40 km/h speed limit was applied in 1999. The existing 60 km/h speed limit still applied to collector and arterial roads (Dyson & Woolley, 2003) however has since been reduced to 50 km/h on collector roads.



Figure 17: Overview of 40 km/h and 60 km/h roads within Unley (Dyson & Woolley, 2003)

Traffic management / calming including road humps had been applied to many streets in Unley, since the 1970's. Many residential streets are straight and short, with junctions that are no longer cross roads. Some minor local roads already had lower speed limits due to their historical (pre-traffic) formation (Dyson & Woolley, 2003).

No additional physical traffic calming measures were implemented in association with the establishment of the 40 km/h speed limit. It has however been identified that there are still

some streets where the only feasible long term solution will be to undertake physical changes, to better match the desired operating speed with the speed limit (Dyson & Woolley, 2003). An extensive marketing campaign was undertaken prior to implementation of the 40 km/h limit (Dyson et al., 2001a).

Changes in 85th percentile and mean speeds prior to 1998, and after implementation (1999-2000), are shown in Figure 18 and Figure 19 (Dyson et al., 2001a).

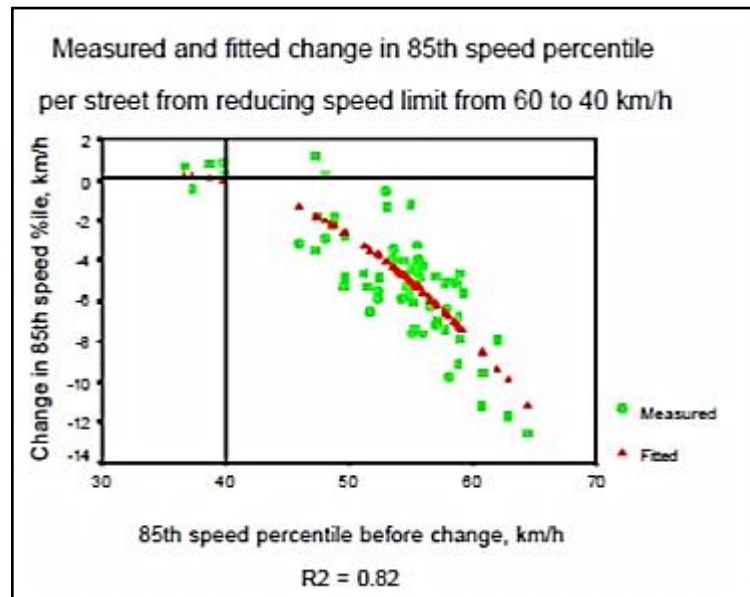


Figure 18: Reduction in 85th percentile speeds on Unley 40 km/h streets (Dyson et al., 2001a)

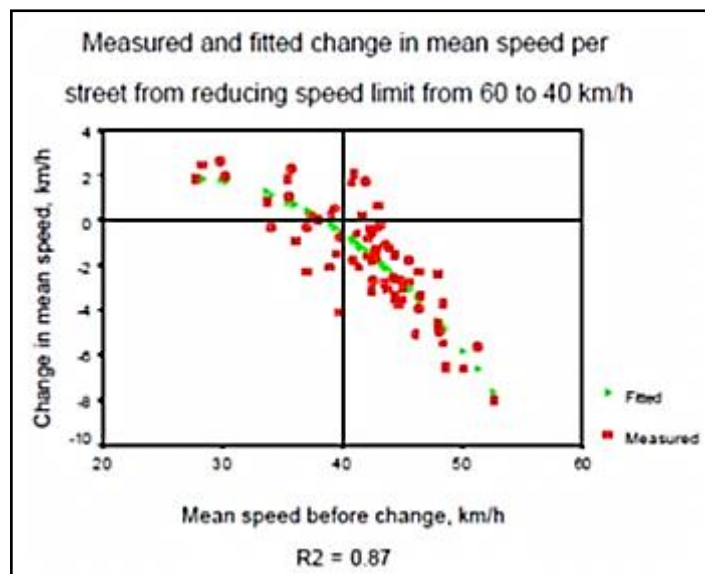


Figure 19: Reduction in mean speeds on Unley 40 km/h streets (Dyson et al., 2001a)

Although it is noted that the before and after studies were not undertaken at the same time of the year, a number of changes in speed were observed. The greatest reduction in speed occurred on streets which had the highest speeds before the introduction of the 40 km/h speed limit (Dyson et al., 2001a).

Streets on which speeds were already around 40 km/h showed little change, however streets where existing speeds were lowest showed a small increase in mean speed. This is thought to be due to drivers choosing a speed to match more closely the prominent signage. Overall there has been a decrease the variation in speed across streets (Dyson et al., 2001a). By 2000, the overall 85th percentile speed was 48.6 km/h, a reduction of just over 1 km/h (Dyson et al., 2001b).

Comparisons of the mean and 85th percentile speed between spring 1998 (prior to implementation) and spring 2001 are shown in Figure 20.

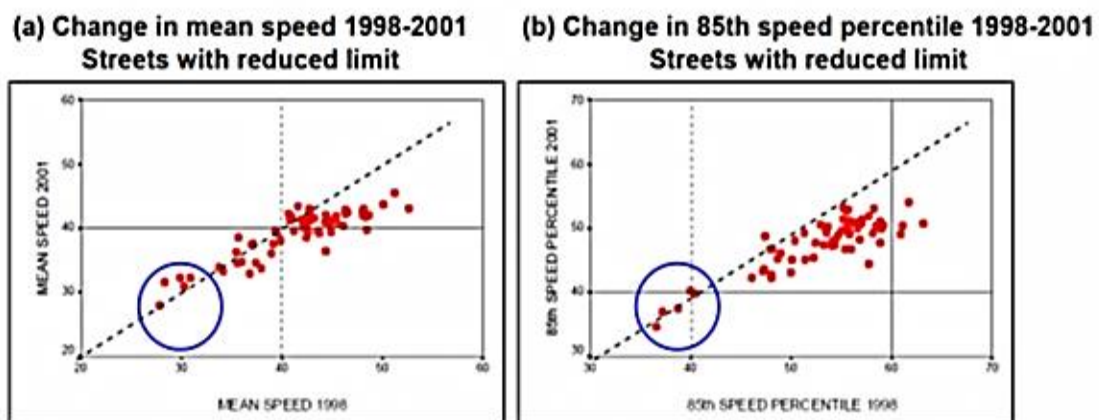


Figure 20: Changes in speed before and after 40 km/h limit (Dyson & Woolley, 2003)

As with the initial results above, streets with lower existing speeds (less than 41 km/h) showed little change in speed. Streets where the mean speed had been 42 km/h or above, prior to the 40 km/h limit, showed a noticeable reduction in the mean and 85th percentile speeds. Variation in mean speed has also reduced by around 30% (Dyson & Woolley, 2003).

Monitoring of speeds undertaken in 2003 indicates that speeds have generally continued to decrease since 2001, as shown in Figure 21 and Figure 22.

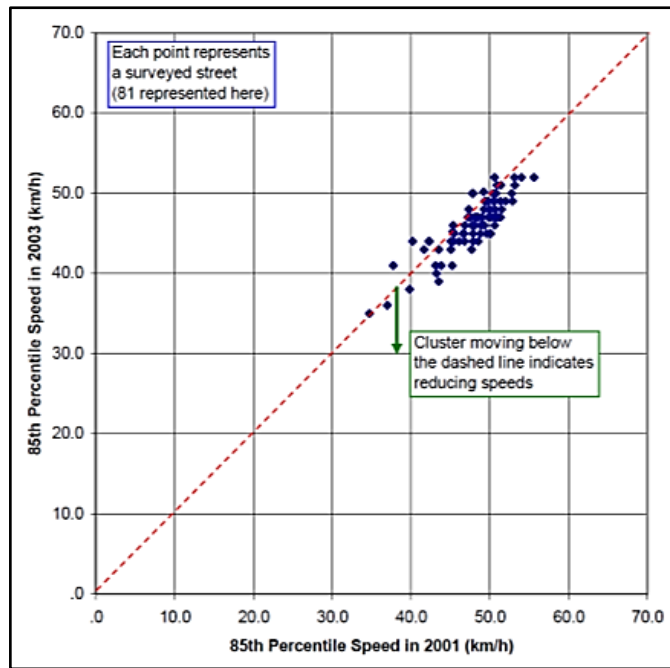


Figure 21: Changes in 85th percentile speed 2001-2003 (Dyson et al., 2004)

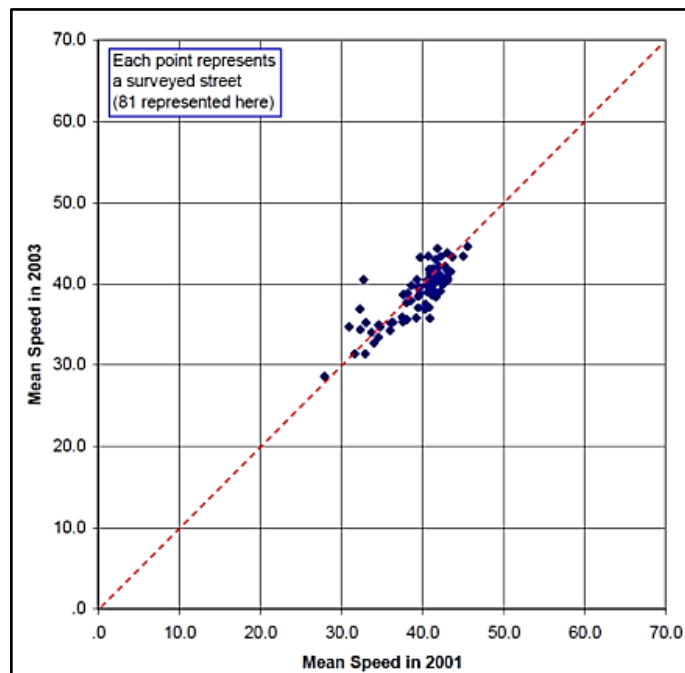


Figure 22: Changes in mean speed 2001-2003 (Dyson et al., 2004)

Despite speeds generally continuing to fall, ten sites still have 85th percentile speeds more than 10 km/h over the speed limit (i.e., more than 50 km/h) (Dyson et al., 2004).

Mean and 85th percentile speeds have also decreased on collector roads, following the 50 km/h DUSL, and it is unclear to what extent this may have contributed to the continued decline in speeds on the 40 km/h roads. Regardless, the speed of the faster vehicles on 40 km/h roads has decreased by around 2 km/h and the average speed has decreased by around 0.5 km/h. This may be the result of selective enforcement although this is difficult to determine (Dyson et al., 2004).

Overall, since 1998, the 85th percentile speeds have fallen by between 6 and 8 km/h on all roads except arterials (where a 60 km/h limit prevails), and minor local roads (where speeds were already low). Mean speeds have also reduced by around 2 km/h on local roads and 5 km/h on collector roads. The greater change in speed on collector roads (due to the 50 km/h DUSL) than local roads is presumed to be related to the higher existing speeds on collector roads (Dyson et al., 2004).

It is important to note that consideration of speeds has focused on approximately 20% of the streets in Unley. The other 80% are mainly constricted and would likely have mean speeds of less than 40 km/h (Dyson et al., 2004).

4.3.1.1 Enforcement

Speed camera enforcement has been used on the local streets in Unley since the 40 km/h speed limit was introduced. After a concentrated effort on 40 km/h roads for the first three months, limited police resources and the need to enforce speeds across the whole of Adelaide, meant that the enforcement effort was reduced. Enforcement has primarily focused on roads where speeding is more likely to occur and / or where there are higher traffic volumes. Enforcement action (at the discretion of police) has occurred in other locations in response to suggestions from local authorities and complaints from residents (Dyson & Woolley, 2003).

In 2001, analysis of speed camera activities and outcomes by South Australia police, within and on the perimeter of Unley, indicated that around 55% of infringements were on 40 km/h streets, 34% on arterials surrounding Unley and 11% on 60 km/h roads within Unley (at that time including collectors) (Dyson et al., 2001b).

Data recorded by the Police indicated that around 40% of speeding notices issued were for vehicles registered to addresses within Unley. 30% of the speeding notices issued were to vehicles registered to addresses south of Unley, presumably associated with people commuting through Unley to the CBD. It is noted that the areas surrounding Unley maintained the 60 km/h speed limit (50 km/h since the introduction of the DUSL in 2003) however the size of Unley is such that drivers would be greatly inconvenienced by re-routing around Unley (Dyson et al., 2001a).

Interestingly, comparison with similar surveys suggests that the percentage of respondents which had been issued with a speeding fine in Unley, is about half that recorded in Adelaide (i.e., on 60 km/h roads) (Dyson et al., 2001a).

A further enforcement study was undertaken between April and June 2002, to quantify the benefits from regular enforcement on local roads. The enforcement program was conducted by South Australia police and was intended to include both speed camera and laser gun operation but laser gun operations were predominantly used. Enforcement was conducted at nine locations and traffic data was collected continuously for these streets (using traffic counter/classifiers). Limited resources meant that morning and evening (8am-9am and 5pm-6pm) enforcement was given the highest priority (Dyson & Woolley, 2003).

Two phases of enforcement were used, firstly, a period of intense enforcement, that was regular and designed to have maximum impact, followed by a second phase of random enforcement and deployment of the Council's Speed Observation Sign (SOS) (Dyson & Woolley, 2003).

In order to determine if there was a lasting effect from the enforcement action, the relationship between enforcement and daily speed data was compared for each site, until any effect disappeared (up to two weeks from the enforcement activity). Coefficients were generated in a multiple regression of daily, per site, mean speed over time and device use. Site effects were removed and weighted according to vehicles per site, per day. These coefficients were then divided by the overall average length of a session (hours) to roughly standardise the effect on daily mean speed of one hour of enforcement or display session (Dyson & Woolley, 2003). The results are shown in Figure 23.

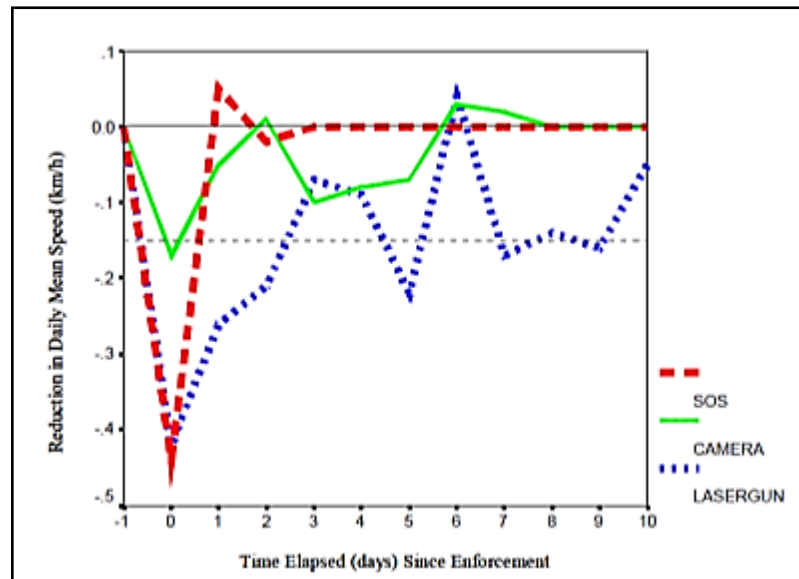


Figure 23: Effect of one hour of speed enforcement on mean speed in Unley (Dyson & Woolley, 2003)¹⁴

Speed enforcement on 40 km/h streets had an immediate impact however the effect was not large (less than 0.5 km/h reduction). The effect from laser gun enforcement was four times the effect of camera enforcement, presumably due to the delay in drivers becoming aware of the camera enforcement (time to receive a fine). There was a statistically significant effect from the laser gun enforcement up to ten days after use. Based on the results, it was concluded that the most efficient enforcement would include at least one hour of laser gun use, per site, on busier 40 km/h streets, every two weeks (preferably on different days of the week) (Dyson & Woolley, 2003).

It was estimated that use of the speed observation sign was of comparable efficiency to the laser gun enforcement, in terms of personnel inputs. It is also likely to result in less public backlash than laser gun enforcement. Use of advisory signs can be managed by Council and enables Council to respond to any perceived need, without deferring to the police. Repeated exposure of the speed advisory sign did not however result in any halo effect and repeated use at the same site suggested that the impact of the device declined 15% with each use (Dyson & Woolley, 2003).

¹⁴ The 95% significance threshold is -0.15 km/h.

4.3.1.2 Public opinion

Prior to implementation, support for the Unley wide 40 km/h speed limit was at 71% (Dyson et al., 2001a). Questionnaires and focus groups were used to monitor residents' attitudes and perceptions. A telephone survey of 880 residents was undertaken in 1998 and 1999, 882 in 2000 and 912 in 2003 (Dyson et al., 2004).

In 1999, 67% of respondents felt that speed had fallen, streets were safe, and supported the Unley-wide 40 km/h speed limit (Dyson et al., 2001a).

In 2000 belief that speeds had reduced remained steady (65%) but there was a decrease in the number of respondents who felt streets were safer (60%) and those supporting the 40km/h limit also dropped (58%) (Dyson et al., 2001a).

In 2003, 62% felt that speeds were slower, 59% though they were safer and overall support had reduced to 52%. There has consistently been polarisation of views however it appears that this is now more even (previously, the proportion with strong view for the 40 km/h limit, outweighed the proportion with strong views against, the 40 km/h limit). In the 2003 survey, there was also a trend towards older residents being more disapproving of the scheme. No age related trend had previously been apparent (Dyson et al., 2004).

Speeds have continued to fall but community support for the 40 km/h scheme in Unley has also fallen. By September 2000, 16 per cent of survey respondents said they had been fined for speeding on a 40 km/h street. Those who had been fined tended to be much more critical of the scheme but this trend was not apparent in the 2003 survey. It would therefore appear that there is a growing acceptance of being fined for speeding on 40 km/h streets (Dyson et al., 2001a).

Monitoring showed polarised views between those who felt additional enforcement should be undertaken and those who were critical of how enforcement was being managed (particularly on wide, busy streets) (Dyson et al., 2001a).

Four, one-hour focus group sessions were undertaken in 2004 (including 31 residents with a mixture of ages, location of residence within Unley, and on different speed limit roads) to monitor and assess community reaction to the 40 km/h limit (and also the 50 km/h DUSL for

collector roads). Some key opinions arising from the focus group sessions include (Dyson et al., 2004):

- 19% of respondents indicated that three speed limits (40 km/h local, 50 km/h collector, and 60 km/h arterial) is too many. Most people living on 40 km/h streets would prefer to return to two speed limits however most living on 50 km/h streets would prefer to keep the three speed limits (Dyson et al., 2004).
- Over half of respondents stated that they would support removal of the 40 km/h limit and adoption of the 50 km/h DUSL. This is despite responses to other questions where benefits had been acknowledged (such as reduced speed, volume of traffic, and safety improvements). This appeared to reflect a view that having a difference in speed limit, between arterial roads and residential roads, was more important (making drivers aware of the need to be more careful) than what the difference in the two speed limits was (Dyson et al., 2004).
- If local and collector roads were to have the same speed limit, respondents with young children indicated a greater support for the adoption of a 40 km/h limit for residential areas, whereas those without young children would prefer a 50 km/h limit (Dyson et al., 2004).
- Respondents also felt that the Unley City Council should publish data showing the impact of the 40 km/h limit and 50 km/h limit on speed, traffic volume, and accident rates (Dyson et al., 2004).

Throughout the surveys of public opinion, questions of equity have also been raised. Some residents felt that introduction of the 40 km/h limit should mean the removal of existing speed humps (traffic management installed prior to the 40 km/h limit). The speed humps achieved a 5 km/h decrease in speeds. Similar roads where the 40 km/h limit has been installed, without speed humps, have resulted in only a 3 km/h reduction in speed. Removing existing speed humps would therefore likely result in increased speeds on those streets (Dyson & Woolley, 2003).

Residents on 60 km/h streets also felt that they had to put up with faster and higher traffic volumes than most residents, although this is likely to have reduced following the 50 km/h DUSL now applying to collector roads (Dyson & Woolley, 2003).

4.3.1.3 Political influence

Whilst it is clear that there has been a long history of public support for traffic management and speed reduction in Unley, there is little information on the level of political support, guidance or direction on the matter. Clearly the 40 km/h limit would not have occurred without political support for the proposal. The trial results have been reported to Council and the lower speed limits have been adopted / retained, suggesting continuing political interest and consideration of the 40 km/h limit.

Unley was the first council in Australia to implement a wide-spread 40 km/h speed limit. This preceded central government focus on urban speeds, which recently resulted in the default urban speed limit being reduced from 60 km/h to 50 km/h. Central government support or direction is not therefore assumed to have been critical in the initiation of the 40 km/h limits in Unley. Conversely the changes in Unley may have spurred consideration of the 50 km/h DUSL by central government.

4.3.2 Outcomes of 40 km/h speed limit

The monitoring of the outcomes, from the 40 km/h speed limit, includes consideration of the effects on: safety, route choice, amenity, and travel time.

4.3.2.1 Safety

The low number of crashes, which occur on residential streets, makes it difficult to positively identify changes, especially over a short time period (Dyson et al., 2001b).

Crash data was collated from the South Australian Traffic Accident Reporting System from 1990-2001, along with provisional data for serious injury crashes from 1990-2002, for the whole Adelaide metropolitan area, and specifically within Unley. The absolute and relative numbers of crash types within Unley, were compared to the whole of Adelaide (Dyson & Woolley, 2003).

By 2002, results indicated that the 40 km/h limit had reduced total crash numbers by around 17% (absolute terms). This may be partly due to decreased traffic volumes in Unley (traffic volumes have overall increased in Adelaide but have declined by 5% on 40 km/h roads in Unley). When all roads within Unley (including those not subject to the 40 km/h limit) are considered, the total crash numbers are relatively static. This is because the crash numbers

are dominated by the numbers on 60 km/h arterial roads. Crashes for the whole of Adelaide have risen by 5% over the same period (coinciding with the increase in traffic volumes) (Dyson & Woolley, 2003).

The number of property-damage-only crashes had decreased by 20% (by 2002) on 40 km/h streets (Dyson et al., 2004). The number of serious injury crashes up to 2002, across Adelaide, remained relatively static but declined by approximately 15% within Unley (including arterial roads) (Dyson & Woolley, 2003).

The 40 km/h limit was credited with a 20% reduction in injury crashes on local and collector roads within Unley, when compared to the number of crashes on arterial roads. Minor injury crashes however rose considerably between 1999 and 2001. It is thought that this apparent increase could be attributed to drivers taking pre-emptive action against increased threat of litigation (Dyson & Woolley, 2003).

Overall, between 1999 and 2002, across all severity levels, road trauma in Unley was 15-20% less than projected had the 40 km/h speed limit not been implemented (Dyson & Woolley, 2003).

4.3.2.2 Route choice

A reduction in traffic volumes on local residential streets, particularly to prevent “rat running” of commuter traffic through the residential areas, was a key outcome sought by the reduced 40 km/h limit in Unley.

Observed changes in traffic volumes on streets subject to the 40 km/h speed limit have been recorded. Local roads have been grouped based on the Average Daily Traffic (ADT)¹⁵. The changes are summarised in Table 8 below (Dyson et al., 2001a).

¹⁵ Minor residential streets are considered to have less than 800 vehicles per day and major residential streets over 2,000 vehicles per day.

Table 8: Reductions in traffic volumes for roads subject to 40 km/h speed limit (Dyson et al., 2001a)

Street characteristic	No of sites	Mean volume reduction	Comments
Minor residential	46	3 per cent	Very wide ranging change
Medium residential	24	7 per cent	Consistent effect
Major residential	9	9 per cent	Consistent effect
<i>Collectors (@ 60 km/h)</i>	7	4 per cent	<i>Wide ranging change (1 to 9 %)</i>

Noting that the before and after traffic volumes were not recorded at the same time of the year, the overall reduction in volume may not be reliable however the relative reductions should be (Dyson et al., 2001a).

Traffic volumes on collector roads (60 km/h) decreased, suggesting that traffic may have been diverted to arterials (although this was not monitored). Minor residential streets are under-represented in the survey sites (to a high degree) such that the proportion of residents who experienced a sizeable reduction (7% or more i.e., on medium and major residential streets) in traffic volumes on their street, would be low (Dyson et al., 2001a).

It is noted that traffic volumes on 67 streets, where the speed limit changed from 60 km/h to 40 km/h, were measured. In 2001, the volume had nominally decreased by around 7-10% compared to existing volumes. Individual sites however varied between a 12% increase and 43% decrease. Some of this variation could be daily fluctuations in traffic volumes (Dyson et al., 2001a).

Since the 50 km/h default urban speed limit, on collector roads, came into effect (2003), traffic volumes on most 40 km/h local roads have increased. The 2003 results conflict with the steady decrease in traffic volumes which had been observed in 1999 and 2001. Although this may reflect some general growth in traffic volumes on local roads, it appears that the change to a 50 km/h default urban speed limit, for collector roads, is the most likely cause (Dyson et al., 2001a).

Comparing the volumes recorded in 2003, with that in 1998 (prior to the 40 km/h limit), the changes include a decrease in volumes on minor and medium residential streets and a decrease on collector roads. Major local roads showed an initial decrease but by 2003 had returned to similar volumes to that existing prior to the 40 km/h limit (Dyson et al., 2001a).

In summary, there appears to be some impact of speeds on route choice.

4.3.2.3 Amenity

Overall traffic volumes decreased on some local roads and on others there was an observed decrease in traffic volumes outside of the peak periods. Decreased traffic volumes outside of the peak periods may however increase the contrast with off-peak periods such that this may not be perceived as improving amenity (Dyson et al., 2001a). The 2003 survey however showed that this contrast was becoming less pronounced in locations where there had been an observed amenity problem (Dyson et al., 2004).

In terms of speed-related impacts, the 2003 survey identified that there were quite low speeds observed on quiet residential streets between 4 am and 7 am (i.e., 'hoons' were not a significant problem). This may contribute to improved amenity for residential areas. It is noted that continued speed reduction of the fastest vehicles, on 40 km/h streets, is also contributing to improved amenity (Dyson et al., 2004).

There do not appear to have been any surveys of noise or surveys of residents' opinions specifically focused on amenity.

4.3.2.4 Travel Time

A Paramics micro-simulation model for Unley was used to compare morning peak hour travel times, for all roads in Unley, under different speed limit scenarios, including (Woolley et al., 2002):

- a. Local roads 30 km/h, collectors and arterials 60 km/h;
- b. Local roads 40 km/h, collectors and arterials 60 km/h;
- c. Local roads 50 km/h, collectors and arterials 60 km/h;
- d. All roads 60 km/h;
- e. All roads 40 km/h;
- f. Local roads 40 km/h, collectors 50 km/h and arterials 60 km/h; and,

g. Local and collector roads 50 km/h and arterials 60 km/h.

The analysis considered the changes in travel time on roads within Unley, and for trips through Unley, such as between Unley and the Adelaide CBD. For trips through Unley, the speed limit changes in Unley affected only part of the overall trip as the speed limit on roads outside Unley remained unchanged. The average travel times under each scenario listed above are shown in Figure 24 and Figure 25.

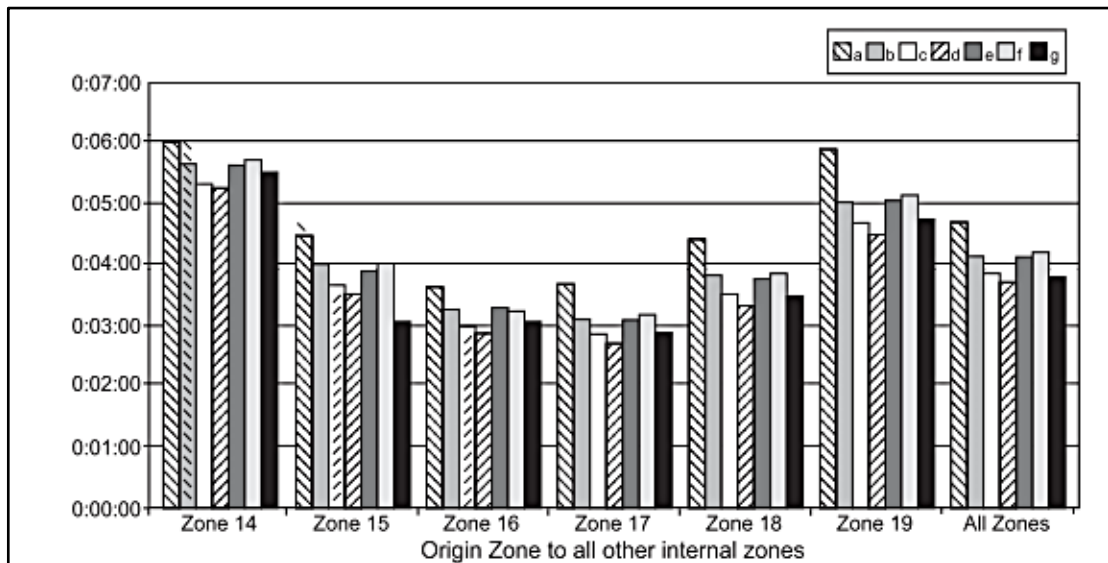


Figure 24: Average travel times within Unley (Woolley et al., 2002)

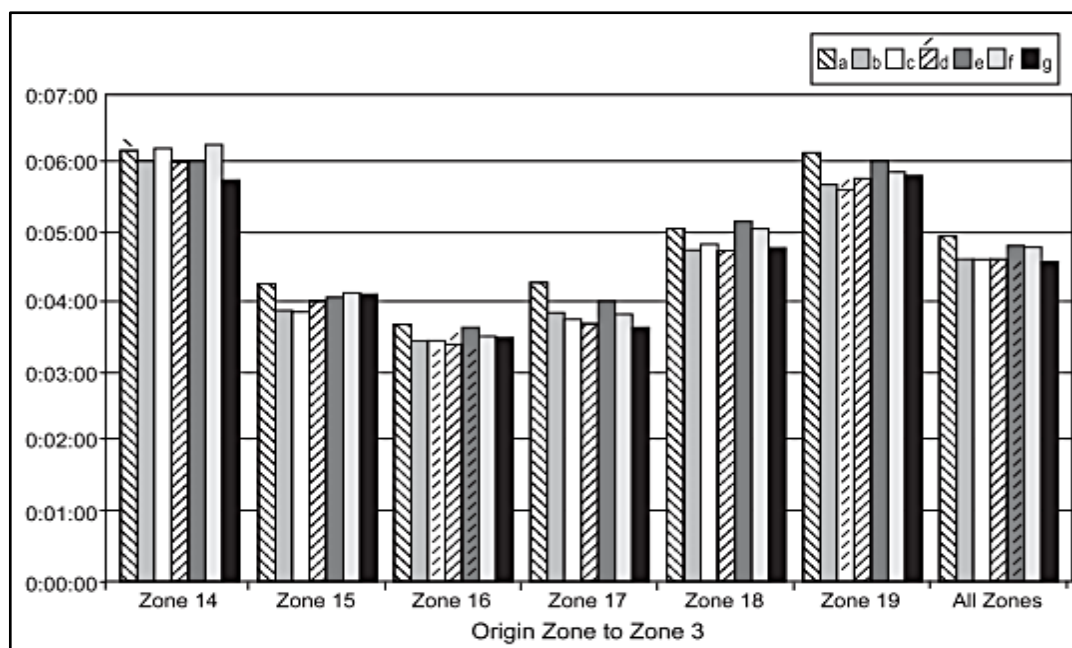


Figure 25: Average travel times through Unley to CBD (Woolley et al., 2002)

The results show that, generally, trip times increase as the speed limit is reduced. If all zones are combined, there is a maximum difference of 60 seconds between scenarios, (a) and (d), for inter-area trips. The variation for trips through Unley is much less, largely because only around 10-15% of the trip distance is on local roads. Similar patterns emerged when considering delays for trips within Unley. The worst delays did not necessarily occur for the lowest speed limits. The 60 km/h scenario (d) frequently resulted in the highest delays, relative to the other scenarios, and this was thought to be due to traffic cutting through on 60 km/h local roads. Interestingly it was noted that the reduction in speeds on collector roads always resulted in increased travel times (Woolley et al., 2002).

It must however be recognised that the signal timing and coordination used within the model, represented the existing scenario (scenario b) and therefore some reductions in travel time could occur, for the other scenarios, by altering signal settings (Woolley et al., 2002).

Overall, it is clear that whilst decreases in speed limits can result in some increase in travel time, on average, this is small (less than 60 seconds). Delay is not always lower for higher travel speeds.

4.3.3 Summary of effects

Whilst initial reductions in speed were small, speed has continued to decrease over time (Dyson et al., 2004). The majority of the public still support the 40 km/h speed limit however the proportion in support has declined over time, at least in part due to the changes to the default urban speed limit (reduced from 60 km/h to 50 km/h).

Initial comparisons of crash rates suggest a reduction in crashes, particularly the most serious injury crashes. Reduced traffic volumes on local roads indicate that some small changes in route choice have occurred.

It is also clear that reducing speeds has only a very small impact on travel times (on average less than 60 seconds) and that delay is not necessarily highest at lower speeds.

Given the likely similarities between New Zealand and Australia (i.e., in driver behavior, road rules, vehicle fleets) similar results might be expected from adoption of reduced speed limits in New Zealand cities.

4.4 Hamilton, New Zealand

To date no speed limit changes have been applied in New Zealand at the same scale as the Unley and Graz examples. Hamilton City Council has however implemented 40 km/h speed limits, in some neighbourhoods, as part of a national demonstration project for Safer Speed Areas.

Hamilton is New Zealand's fourth largest urban area and has around 134,000 residents (Hamilton City Council, 2011). Almost one crash in five, that occurred in the city, in the 2005-2009 period listed speed as a contributing factor (Hamilton City Council, 2012a).

Almost every school in Hamilton is already part of a 40 km/h zone, recognising the high number of vulnerable road users in these locations. The demonstration project is enabling 40 km/h speed limits to be introduced in other areas and Hamilton is thus one of the first cities in New Zealand to introduce 40 km/h speed limits in areas other than around schools (Hamilton City Council, 2011).

Unlike the Graz and Unley case studies, the Hamilton speed limit changes have not been in effect long enough to enable detailed analysis of the results. However, the limited results available and the approach to implementing the changes are outlined below.

4.4.1 Approach / implementation

The 40 km/h speed limit commenced on the 17th of October 2011 and covered eight areas, as shown in Figure 26 (Hamilton City Council, 2011).

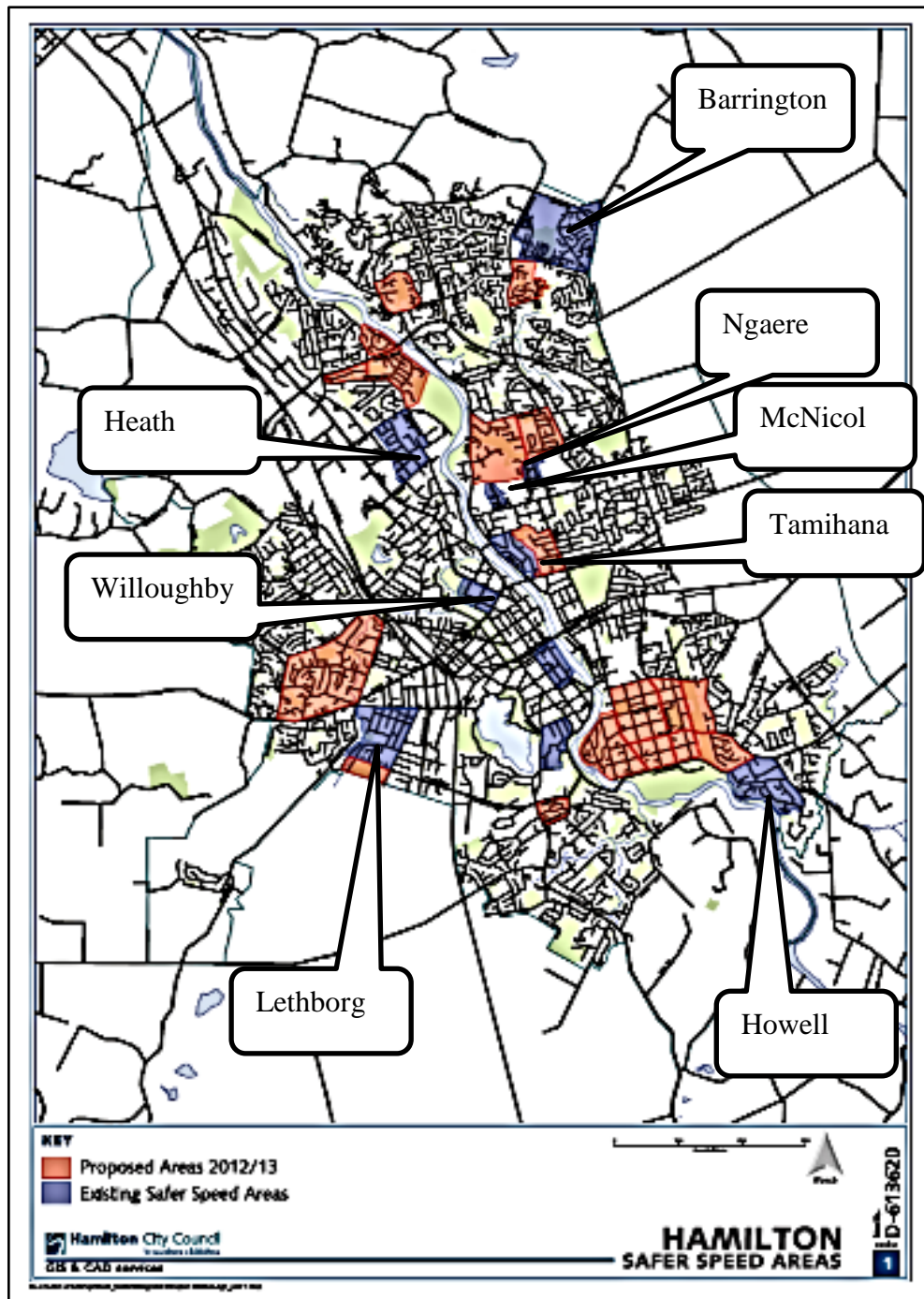


Figure 26: Location of the eight Safer Speed Areas (Hamilton City Council, 2012a)

The Council is ultimately seeking to provide every resident in Hamilton with appropriate speeds, for their local street, although the Safer Speed Areas would not include major commuter routes or designated high traffic roads (Hamilton City Council, 2012a).

Education and awareness campaigns have been undertaken including creation of a Safer Speed Areas website, outlining what, where, and why, safer speed areas have been

implemented, and how to request one. Online advertising was also used, consisting of moving messages illustrating the ability to stop at 40 km/h compared to 50 km/h, and was delivered through Stuff.co.nz/Waikato Times, Yahoo and Facebook (Hamilton City Council, 2012b).

The Safer Speed Areas physical work and speed limit signing was completed late in 2011. The Council has also been working to develop a specific road marking for the Safer Speed Areas to tie all the Safer Speed Areas together so that education and marketing could focus on making these areas more recognisable and memorable. This was particularly desirable given the geometry and style of the eight demonstration project sites, within Hamilton, are all very different. The final design was installed in a number of locations throughout the demonstration projects, in May 2012, with particular focus on areas where travel speeds are higher than desirable (Hamilton City Council, 2012b).

Road markings and signage are considered to be one of the most cost effective methods of speed management and the Council considers that they will be very useful when introducing further Safer Speed Areas though out the City on a tight 'no frills' budget (Hamilton City Council, 2012b).

Physical changes to the roads in the demonstration project areas were minor as many of the roads had previously had physical devices installed as part of traffic calming programmes. For example, traffic calming implemented in Heath, during 2009, had already achieved around a 15 km/h reduction in mean speeds. Therefore changes associated with the demonstration areas typically only included threshold treatments at the entrances, pedestrian improvements (e.g. refuge islands, platforms, splitter islands), and installation of signage (Hamilton City Council, 2012b).

Central government has provided funding through a 55% subsidy for Safer Speed Area work. The remaining 45% is funded by the Hamilton City Council and budgeted for within the 10 year plan (project 12021.0) (Hamilton City Council, 2012b).

Information on the New Zealand Transport Agency websites shows National Land Transport funding totaling \$523,500 approved for 'Road safety promotion 2012-2015' for the Hamilton City Council (i.e., approximately 55% of the stated \$931,000 total phase cost) (New Zealand Transport Agency, 2012).

The “Hamilton 10 Year Plan” (Hamilton City Council, 2012c) identifies \$967,000 for safer speed areas in 2012-2015 and \$2,756,000 for 2015-2022. However a “Report to Hamilton Public Transport Joint Committee” (Consedine & Allen, 2012) recommends some 41 additional safer speed areas to be implemented prior to 2015 with an estimated cost of around \$532,224 each financial year (totaling around \$1,596,672), for traffic calming engineering features, to slow traffic to the proposed 40 km/h speed limit (Consedine & Allen, 2012).

Monitoring of traffic speeds and volumes was undertaken for the locations where traffic speeds and volumes were highest prior to implementation of the 40 km/h speed limits. The results indicated a decrease in speeds of between 0-6% and a decrease in traffic volumes in all cases. The table below summarises the results (Hamilton City Council, 2012b).

Table 9: Summary of change in speed and traffic volumes for Safer Speed Areas (Hamilton City Council, 2012b)

Location	Change in mean speed	Change in 85th percentile speed	Change in traffic volume
Hudson (part of Howell Area)	-3 km/h (49→46 km/h)	-3 km/h (58→55 km/h)	-26% (880→648 vpd)
Howell	No change (44 km/h)	No change (51 km/h)	-20% (1,575→1,263 vpd)
Lethborg	-1 km/h (44→43 km/h)	-1 km/h (52→51 km/h)	-13% (562→487 vpd)
Casey (Tamihana)	-1 km/h (48→47 km/h)	No Change (56 km/h)	-23% (1,457→1,118 vpd)
Barrington	-1 km/h (44→43 km/h)	-1 km/h (54→53 km/h)	-23% (674→520 vpd)
Willoughby	-2 km/h (48→46 km/h)	-1 km/h (54→53 km/h)	-42% (4,261→2,475 vpd)
Heath	No existing (44 km/h)	No Change (52 km/h)	-8% (1,782→1,648 vpd)

As outlined above, traffic calming had already achieved a reduction in mean speeds in Heath. This may explain why no further changes were observed following the installation of the 40 km/h speed limit, as the existing speeds are generally similar to or lower than, the speeds achieved after implementation at the other sites shown.

Monitoring has been undertaken to evaluate both the effectiveness (traffic volumes and speeds) and awareness, by the general public, of the Safer Speeds Areas. The findings are

used to develop the 2012/13 programme of physical works, education, and marketing (Hamilton City Council, 2012b).

4.4.1.1 Political influence

The 40 km/h limits were approved by the Council's Strategy and Policy Committee (on 21.09.11) with the Chairperson (Councillor Maria Westphal) saying *"I'm pleased to see this get the green light, as reducing speed limits by 10 km/h on our local streets will bring significant road safety benefits to all road users, particularly children on their way to school, cyclists and walkers, and be a good first step in making these streets available again to the community"* (Hamilton City Council, 2011).

Central government recognition of the safety benefits of Safer Speed Areas, and the provision of a 55% subsidy, have been critical in enabling the project to proceed (Hamilton City Council, 2012a).

The success of the Safer Speed Areas appears to reflect strong leadership at council level and support from central government.

4.4.1.1 Public opinion

Prior to implementing the 40 km/h speed limits the Council undertook consultation with the community, and key stake holders, over four weeks, including distribution of more than 1,000 information leaflets and an awareness campaign. 20 submissions on the proposal were received, half in support and half in opposition (Hamilton City Council, 2011).

A survey of the general public, in April 2012, interviewed 499 people randomly selected in Garden Place, asking them what they knew about the Safer Speed Areas concept, what they thought they should do in one of these areas, and what marketing / educational activity they had seen. The results indicated that knowledge about the scheme varied but that the signs were generally self-explanatory. Most people had not heard any of the advertising associated with the project (posters, radio and newspaper) but it was acknowledged that the Safer Speed Areas "brand" had only had a few months exposure (Hamilton City Council, 2012b).

Two surveys of residents in Safer Speed Areas have been undertaken, one prior to confirmation / development of the project areas, and one in February 2012 (approx. 3 months

after implementation). The February survey received 11.7% of the 4,000 surveys distributed, which is considered to be a very good response rate for the type of survey (however there could still be some response bias). The earlier survey achieved an 8.5% response rate. The results suggest that residents generally understand the Safer Speed Areas concept and do not consider them to be an inconvenience. Residents generally felt safer, that drivers were more courteous, and were try trying hard to obey the 40 km/h speed limit. 29% of respondents indicated that they were now more willing to walk or cycle in the area (Hamilton City Council, 2012b).

The residents survey also identified that there had been no noticeable change in drivers short-cutting through the area, or in the activity of 'hoons', despite the decrease in traffic volumes shown in Table 9. Overall there was a balance, between those who agree and disagree, about whether a Safe Speed Area should be applied to all local streets in Hamilton (Hamilton City Council, 2012b). The results of the February, residents opinion survey are shown below.

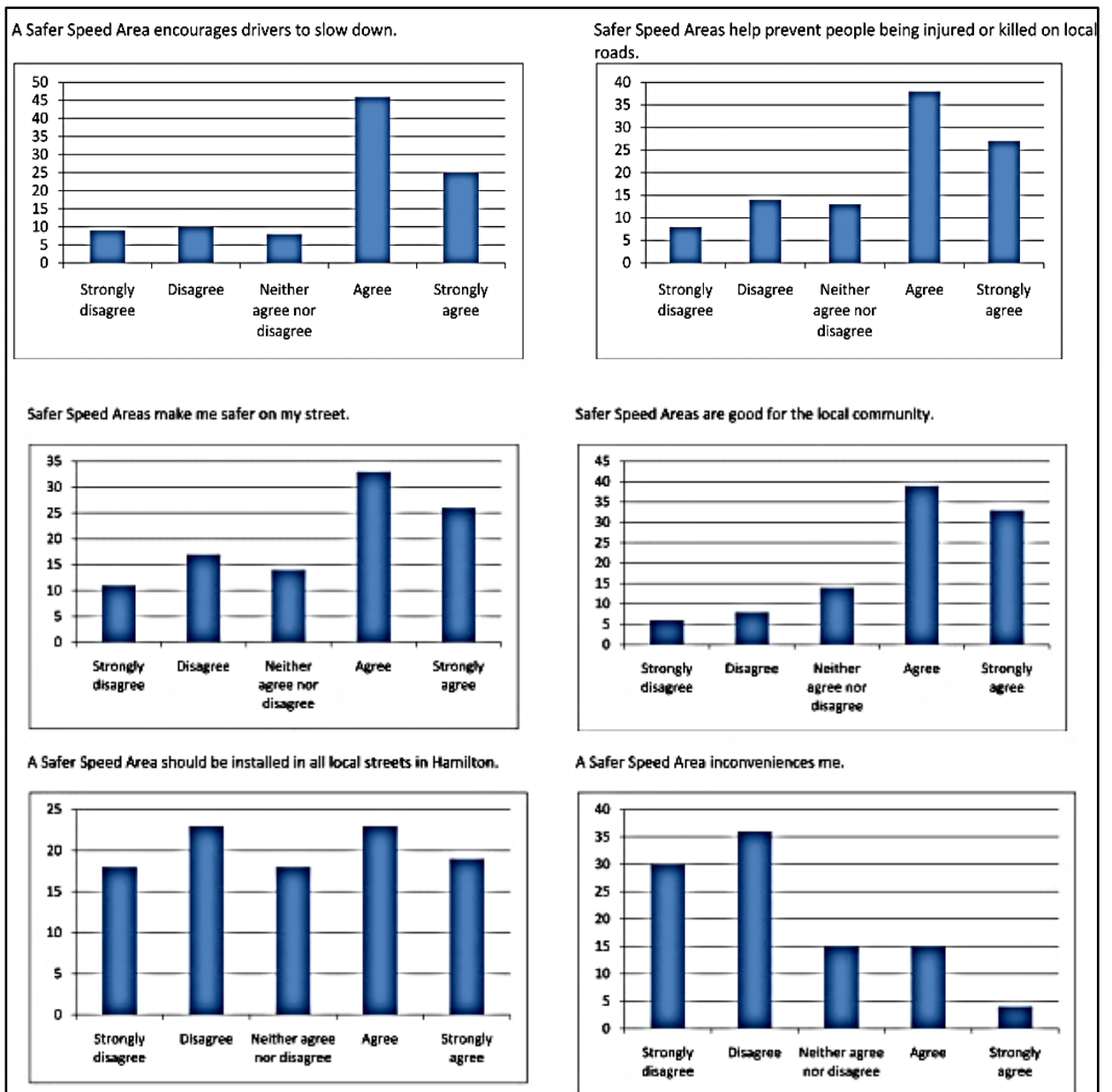


Figure 27: February survey results (Hamilton City Council, 2012b)

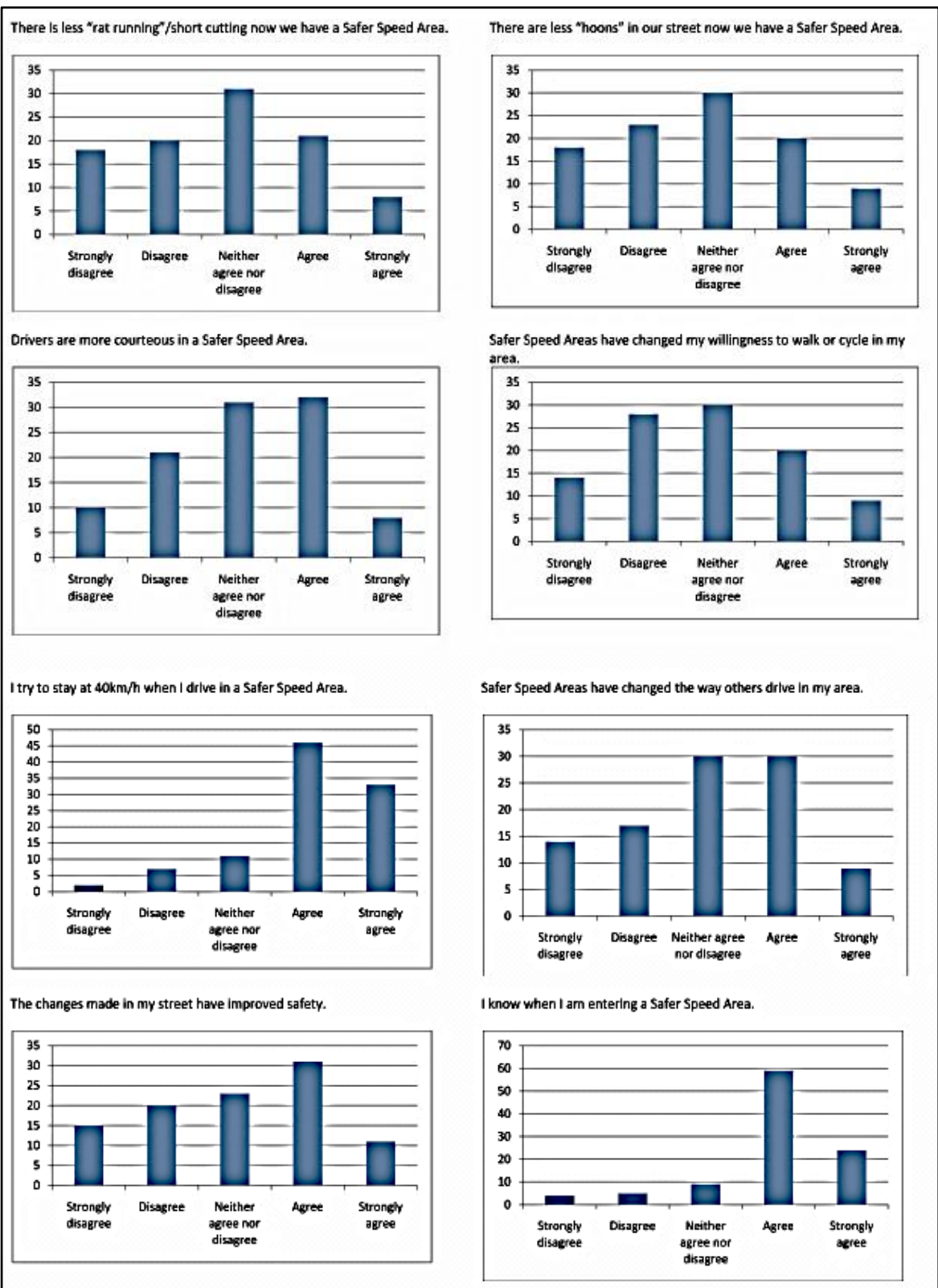


Figure 28: Additional February survey results (Hamilton City Council, 2012b)

4.4.2 Summary of effects

The 40 km/h Safer Speed Areas in Hamilton provide a good New Zealand case study in terms of the approach to implementation and particularly the costs, political and public opinions, on reducing speeds in New Zealand. It appears that there has been both central and local government support for the project, and central government funding was critical in delivering the speed reductions. Residents surveys in Hamilton suggest that a majority (around 70%) consider that the Safer Speed Areas are good for the community, and there is currently even numbers of support and opposition to application of Safe Speed Areas to all local streets in Hamilton (Hamilton City Council, 2012b).

Unfortunately at the time of writing, the Safer Speed Areas had not been in effect long enough for any safety effects to be measured. Other than questions related to willingness to walk and cycle, it does not appear that the Council (or New Zealand Transport Agency) is planning to measure other outcomes (such as travel time, mode-shift or air pollution) associated with the reduced speed limits. Consideration of such effects would be useful as Council develops further 40 km/h areas.

4.5 Discussion: case study findings

The three case studies presented above have been applied at different scales, only in Hamilton was the reduced speed limit accompanied by some (limited) physical measures to encourage lower speeds. The lower speed limits in Unley and Graz have been in effect for a much greater period of time and thus more information on the effects is available.

In Graz, the 30 km/h limit was applied to the whole city and in Unley, the 40 km/h limit was applied suburb wide. In both cases, the speed limit on arterial roads (50 km/h in Graz and 60 km/h in Unley) was not reduced, and in Unley collector roads were also excluded from the 40 km/h limit (however the reduction of the default urban speed limit means collector roads now have a 50 km/h limit). Both case studies sought to reduce speed primarily through the adoption of lower speed limits, with associated enforcement, and education campaigns. Trial areas were used prior to full implementation, in both cities.

The reduction of the speed limit resulted in both the mean and 85th percentile speeds reducing. Initial results in Unley indicated only a 1.0 km/h reduction in 85th percentile speeds however speeds have continued to fall. By 2004, 85th percentile speeds had reduced by

around 6-8 km/h (mean speeds had reduced by around 2 km/h by 2004) (Dyson et al., 2004). Of the streets measured in Hamilton it appears that reductions in speeds have also been achieved (Hamilton City Council, 2012b).

In Graz, there was initially a 2.8 km/h reduction in mean speed and a 4.2 km/h reduction in 85th percentile speeds. By 2002, the mean and 85th percentile speeds had however increased such that the reduction was only 0.4 km/h for mean speeds and 1.9 km/h for 85th percentile speeds (Fischer, 2010). Whilst there was no information available on speeds since 2002, accident trends (which had crudely followed the changes in speed to 2002) have declined since 2006. Adoption of a private speed control company, and contracting of City staff to police for enforcement, may be resulting in speeds reducing again.

Whilst the majority of the public support the reduced speed limits, in both cities, ongoing levels of support have differed. Generally support has increased in Graz and declined in Unley. In Unley public support for the 40 km/h speed limit has slowly declined, this appears to at least partly reflect a view that the 40 km/h limit is not so important, since the default urban speed limit has been reduced to 50 km/h. Some residents also feel that having three speed limits is too confusing (40 km/h on local roads 50 km/h on collectors and 60 km/h on arterials) (Dyson et al., 2001a).

In Graz, public support was initially at around 64% reducing to 44% right before implementation, then increasing steadily to around 81% in 2002 (Wernsperger & Sammer, 1995; Fischer, 2010). The reasons for the different trends are difficult to determine and could reflect a number of different factors. In Unley changes to the default urban speed limits have played a part. Other factors could include the level of enforcement and number of persons fined, although the Unley surveys indicated a growing acceptance of fines for speeding on 40 km/h roads. The level of public awareness, debate, and information provided to the public around the benefits (e.g. crash reductions), could also affect the level of support. In Unley the surveys indicated that there was some desire for additional information. It is not clear what level of information on the results of the 30 km/h limit is provided to residents in Graz.

Residents surveys in Hamilton suggest that a majority (around 70%) consider that the Safer Speed Areas are good for the community. There is currently even numbers of support and

opposition, to application of Safe Speed Areas to all local streets in Hamilton (Hamilton City Council, 2012b).

There is limited research available on the safety benefits in Unley, given the amount of data needed to accurately determine changes in crash rates. Initial results suggest that, across all severity levels, there has been a 15-20% decrease in crashes from the predicted crash rate, had the 40 km/h limit not been implemented. There has been an increase in minor injury crashes but this is thought to reflect increased reporting (Australia wide) of these crash types (to avoid possible litigation) (Dyson & Woolley, 2003).

In Graz, more comprehensive studies have been undertaken (for example, comparing the results to similar cities where increased enforcement alone was undertaken). Initial results (year before and after) indicated a 24% decrease in serious and 12% decrease in minor injury accidents. There was also a notable decrease (considered over a number of years) in accidents involving pedestrians and cyclists, despite cyclist numbers continuing to increase. Whilst crash rates dropped initially (over 1993-1996), they then increased again (although not to pre-1992 levels). This may reflect the fact that the speed reductions initially observed were not sustained. Crash numbers between 2006 and 2009 steadily decreased again, and may reflect increased enforcement since 2006 (initially by a private company and then by City staff contracted to Police). No speed results were available beyond 2002.

Mode shift has not been considered in Unley. In Graz, comprehensive surveys of travel before and after the new speed limit did not indicate any mode shift. The Graz surveys also showed only a very small change in route choice; only 1.5% of trips taken after the 30 km/h limit occurred on a different route (Fischer, 2010). It is also noted that traffic congestion on arterial routes, anticipated by the public, did not eventuate.

In Unley, monitoring of traffic volumes suggests that small reductions in traffic volumes occurred (3-9% depending on the type of local road) (Dyson et al., 2001a). The monitoring undertaken did not allow conclusions to be drawn as to whether this was because traffic was diverted to arterial roads or re-routed around Unley (although the size of Unley would mean that re-routing would necessitate a considerable deviation from existing routes). Traffic volumes have also decreased, on all roads surveyed, and this is assumed to be associated with changes in route choice.

Residents opinion surveys, in Hamilton, suggested that 29% of respondents were now more willing to walk or cycle in the Safer Speed Areas but whether this has translated into actual increases in walking and cycling has not been monitored (Hamilton City Council, 2012b).

Noise before and after implementation was measured in Graz and it was concluded that noise pollution had slightly decreased. Noise was not measured in Unley. Neither of the case studies surveyed public opinion on amenity or pleasantness of streets as a result of the speed limit reductions. Amenity related effects were not monitored in Hamilton although responses to the survey questions indicated strong agreement that Safer Speed Areas were “good for the community” (Hamilton City Council, 2012b).

The impact on vehicle emissions in Graz was also monitored. The difference in vehicle emissions between 50 km/h and 30 km/h speed limits differed by type of vehicle and driver. They found the 30 km/h limit resulted in higher levels of carbon monoxide (3.8% increase), no noticeable effect on hydrocarbons, and a notable reduction (24%) on nitrogen oxide emissions. Overall however they concluded there was no significant change as arterial roads, where the speed limit had not changed, accounted for 92-95% of all vehicle emissions (Wernsperger and Sammer, 1995). It was also concluded that fuel consumption did not change noticeably.

The impact on vehicle emissions was not specifically monitored for Unley however consideration of emissions for 40 km/h streets in South Australia, indicated similar results to that reported for Graz.

Travel times have been modeled for Unley and results suggest that travel times have increased slightly (on average by less than 60 seconds). Traffic congestion may however have decreased. In Hamilton around 65% of respondents disagreed that the 40 km/h limit was an inconvenience to them.

Overall, in Graz, Unley, and Hamilton, reductions in speed have been successfully implemented. Speed reductions appear to have been less well sustained in Graz but speed has continued to decrease in Unley. Both Unley and Graz appear to have achieved noticeable reductions in crash rates, particularly for serious crashes. Both case studies also have majority support, however, this is decreasing in Unley, and increasing in Graz. Neither study specifically surveyed public perception of amenity, however, noise monitoring suggests

noise pollution has decreased slightly on 30 km/h streets in Graz. Travel times have only been considered in Unley and appear to have increased slightly, although congestion may have decreased.

The Hamilton case study indicates political and public support for Safer Speed Areas. It is too early for safety effects to be considered and other than residents opinion surveys, it appears that there is no consideration being given to monitoring other effects, such as mode-shift.

5 Survey of Industry Professionals

This section outlines the survey of New Zealand industry professionals undertaken as part of this research.

5.1 *Survey aims, objective and hypothesis*

The aim of the survey was to identify the perceptions and opinions, of New Zealand industry professionals, about reducing urban speeds. This primarily included engineers and planners / policy analysts. It also included academics and other related professions, such as landscape architects and urban designers, that are involved in sustainable land transport.

The objective was to consider opinions on how reducing urban speeds could contribute towards achieving sustainable land transport. This included respondents identifying what they thought the key benefits and constraints may be and whether they would support reducing urban speeds in New Zealand.

It is hypothesised that industry opinions would be consistent with the findings from the literature review and case studies.

5.2 *Survey method*

The survey was undertaken using the Survey Monkey online software package. This allowed the survey to be distributed via a URL link in electronic newsletters of the following industry groups:

- Institute of Professional Engineers New Zealand (IPENZ) Transport Group *Mini Roundabout* (15 May 2012).
- IPENZ *Engineering Direct* (February 23 and March 1, 2012).
- New Zealand Planning Institute (NZPI) *Planning Focus* (February 9, 2012).
- New Zealand Institute of Landscape Architects (NZILA) via a branch email (February 2012).

The survey was advertised as seeking industry professionals' opinions on sustainable land transport. This broader topic was used to help reduce potential response bias associated with respondents interested specifically in urban speeds. A total of 126 respondents started the survey and 103 (81.7%) respondents completed the survey.

The survey contained a brief introduction, nine questions and a section for respondents to enter the optional prize draw (for a \$50 Whitcoulls voucher). The optional prize draw was an incentive to encourage professionals to complete the survey. 76 respondents entered the optional prize draw, with one respondent being randomly selected and sent the \$50 Whitcoulls voucher.

A complete copy of the survey is attached as Appendix 3. The questions were ordered such that the detailed questions on reducing speed, were last, to avoid biasing answers to the questions which considered the opinions on a range of sustainable transport methods (including speed). All questions where ranking was required were undertaken on a 7 point scale, which provided the option of a neutral or no change response.

In order to be able to compare between different subgroups, all results were analysed as percentages or averages. All subgroups that were separately analysed were selected so as to have similar numbers of respondents, or where this was not possible, so that there was a minimum of 30 respondents in each subgroup. No academic subgroup was analysed given the low number of respondents whose work experience include academic work (13 respondents) and because most also selected engineer or other (planner or policy analyst). Other subgroups include years of experience (0-10, 11-20 or 21 plus years) and respondents with and without speed-related experience.

The aim of the survey was to gain some general understanding of industry opinions. Other than presenting average results and percentages it is not intended to undertake any detailed statistical tests. This largely reflects the fact that many statistical tests (for example, 'T-tests') are not appropriate for opinion data (albeit that some authors still utilise such tests for opinion data without any discussion on the appropriateness of doing so). The reason for this relates to the type of information obtained and the structure of the questions. The data obtained from these questions does not meet all of the underlying assumptions for the common statistical tests, for example, the questions in this survey include options which are not mutually exclusive (so chi-squared test would be inappropriate) (Romano et al., 2006).

The survey information obtained provides some general insights into professional opinions and complements the findings of the other sections without the need for detailed statistical testing.

5.3 Survey results

The survey results for each of the nine survey questions are summarised below.

5.3.1 Question 1: years of experience in the industry

The first question asked respondents to indicate how many years of experience they had in the industry (0-2, 3-5, 6-10, 11-20, 21-40 years or 41 years or more). The results are shown in Table 10.

Table 10: Years of experience in industry

Years of experience	Count	Percentage
0-2	13	10
3-5	13	10
6-10	23	18
11-20	40	32
21-40	31	25
41 or more	6	5
Total	126	

The results indicate a range of different levels of experience. Roughly one third of respondents fell within each of the ‘0-10 years’, ‘11-20 years’ and ‘more than 21 years’ ranges, which are adopted as subgroups for analysis of questions 4-9.

5.3.2 Question 2: sustainable land transport exposure

Question two asked respondents to identify which of the following areas of sustainable land transport they had been involved in:

- Walking / cycling;
- Effects of transport on the natural environment (e.g. air, water);
- Effects of transport on the human environment (e.g. noise, social);
- Vehicle / fuel efficiency;
- Public transport;
- Local area traffic management (e.g. traffic calming);

- Speed (e.g. speed limits or speed management);
- Travel demand management (e.g. mode shift, travel plans, behaviour change);
- Road safety; and,
- Other (please specify).

It is noted that 4% of respondents skipped the question and 2.4% selected other. Of the other responses, this ranged from experience in other areas of sustainable transport to having no experience in this area. Some of the other responses could have been included within one of the above categories (for example, “*effects on landscape*”). Whilst the work may have been related, this may not have been from the perspective of sustainable transport, and as such these responses have been left as a separate category.

The results are shown in Figure 29.

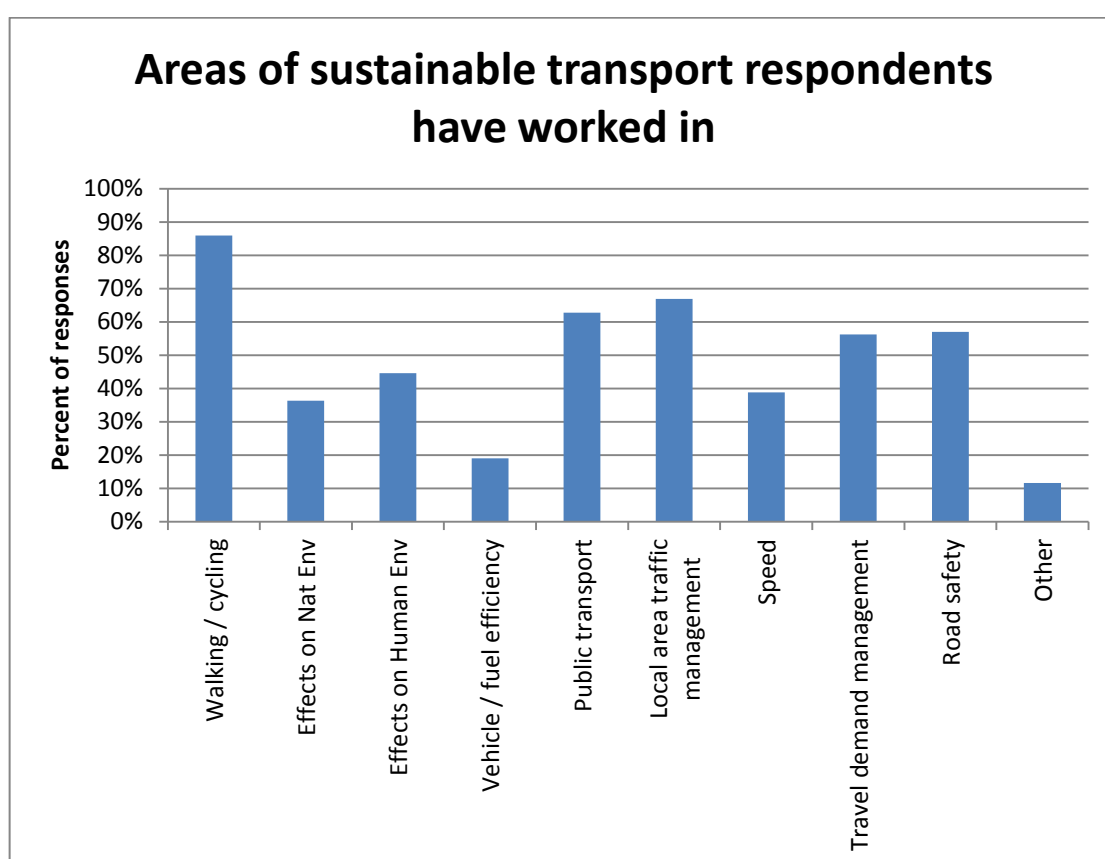


Figure 29: Involvement in different areas of sustainable land transport

Respondents could select as many options as applicable and on average selected 4-5. This suggests that most respondents had a range of exposure to different areas of sustainable land

transport. Respondents that stated 'other' included, no experience, integrating land use and transport, urban design (3 respondents), landscape design / effects (2 respondents), climate change, renewable fuels, site design (car parks / access), asset management, freight, testing council standards, developing walking and cycling network planning, and accessibility planning (2 respondents).

More than half the respondents had experience with walking / cycling, public transport, local area traffic management, travel demand management, and road safety. It must however be noted that experience does not necessarily infer expertise and the level of involvement in these areas is likely to vary, for example, it is unlikely that 80% of respondents would have had a lot of practical experience in planning for walking and cycling. Some respondents may simply have had some secondary involvement in walking and cycling, as part of wider projects. It is also possible that those with involvement in walking and cycling may have been more likely to respond to a survey on sustainable transport therefore this could also represent a response bias.

Around 40% of respondents had some experience in speed-related work (e.g. speed limits or speed management). Responses from respondents who had speed-related experience were separated in order to identify what other areas of sustainable land transport they had been involved in. This is shown in Figure 30.

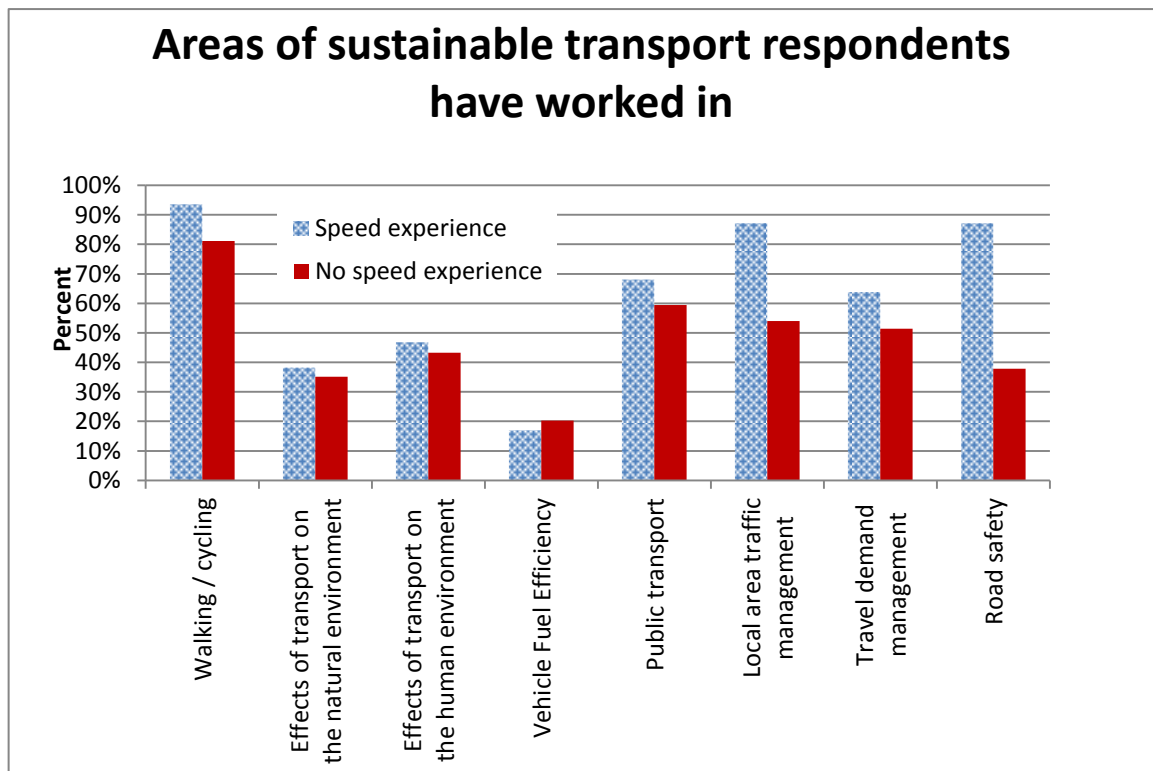


Figure 30: Involvement in different areas of sustainable land transport, respondents with and without speed-related experience

This shows that over 90% of respondents who had exposure to speed-related work also had exposure to walking and cycling related work. Respondents with speed-related experience were more than twice as likely to have experience in road safety as those with no speed-related experience. They were also more likely to have experience with local area traffic management. This may reflect the two most common reasons to reduce speeds in New Zealand.

The responses of those with and without speed-related experience are also analysed as subgroups for questions 4-9. It is noted that those with speed-related experience were also more likely to have experience in all other topics (except vehicle fuel efficiency), this may indicate that those with speed-related experience are involved in a greater variety of work, or work that has a broad scope. Given there are a limited number of locations where reduced urban speeds have been applied in New Zealand a number of respondents may have limited or peripheral involvement in speed-related work.

There was an increase in speed-related experience, with years of experience in the industry. Around 24% of those with 0-10 years of experience had speed-related experience compared to 43% for the 11-20 years of experience group and 53% for the 21 years plus experience group.

5.3.3 *Question 3: type of industry experience*

Question 3 asked respondents to identify which of the following sectors of the industry they had worked in:

- Consultant engineer;
- Consultant other (e.g. planner, policy analyst);
- Local government engineer;
- Local government other (e. g. planner, policy analyst);
- Central government engineer;
- Central government other (e.g. planner, policy analyst);
- Academic;
- Other (specify).

The results are shown in Figure 31.

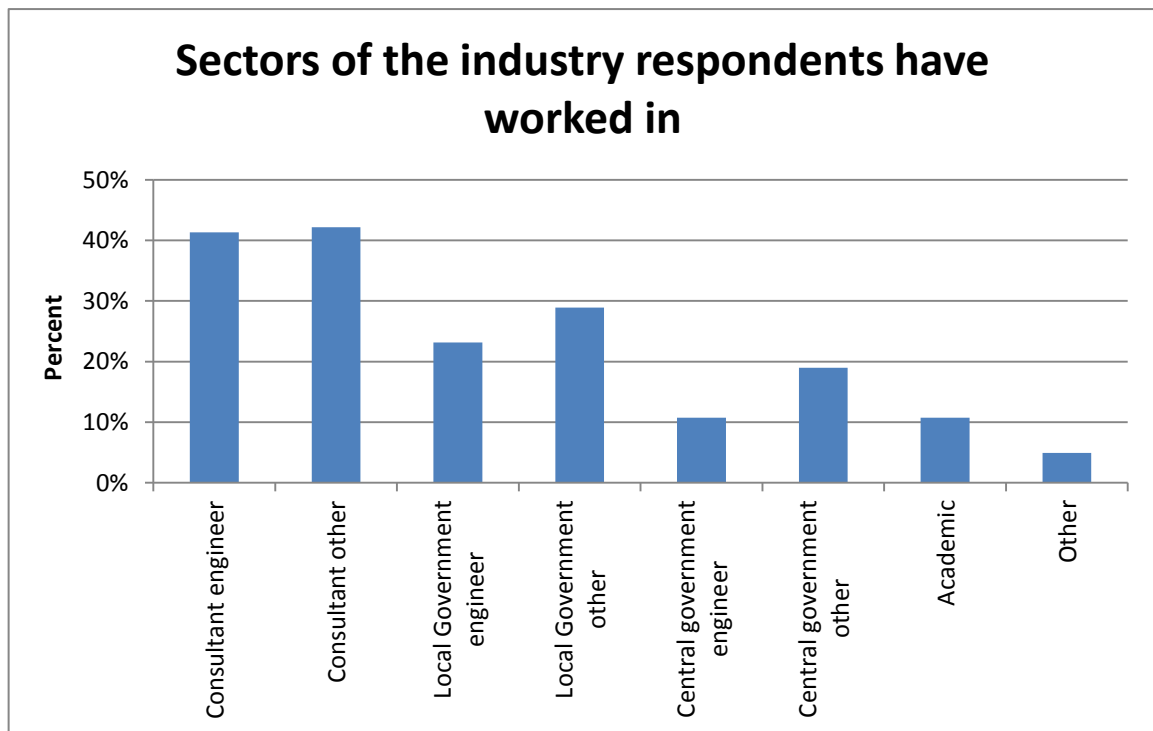


Figure 31: Sectors of industry respondents have worked in

This question allowed respondents to select as many options as applicable. A large number of respondents had worked for a consultancy (83% of respondents) and for a local or central government organisation (82% respondents). Given respondents' high level of experience in both consulting and government roles, it was not considered useful to analyse these as sub-groups.

Both engineers and others (planners and policy analysts – here on in referred to as planners) were well represented within the survey respondents. Analysis showed that only a small proportion of respondents had worked as both an engineer and planner. More respondents in the 0-10 years of experience were planners (45% of respondents) than engineers (27% of respondents) and the reverse occurred, for the 21 plus years of experience (24% planners and 42% engineers).

Of the six 'other' responses, three were landscape architects and one respondent had no work experience, the other two were a contractor and an environmental manager. Five respondents skipped this question.

Figure 32 shows the different sectors of the industry respondents with and without speed-related experience have worked in.

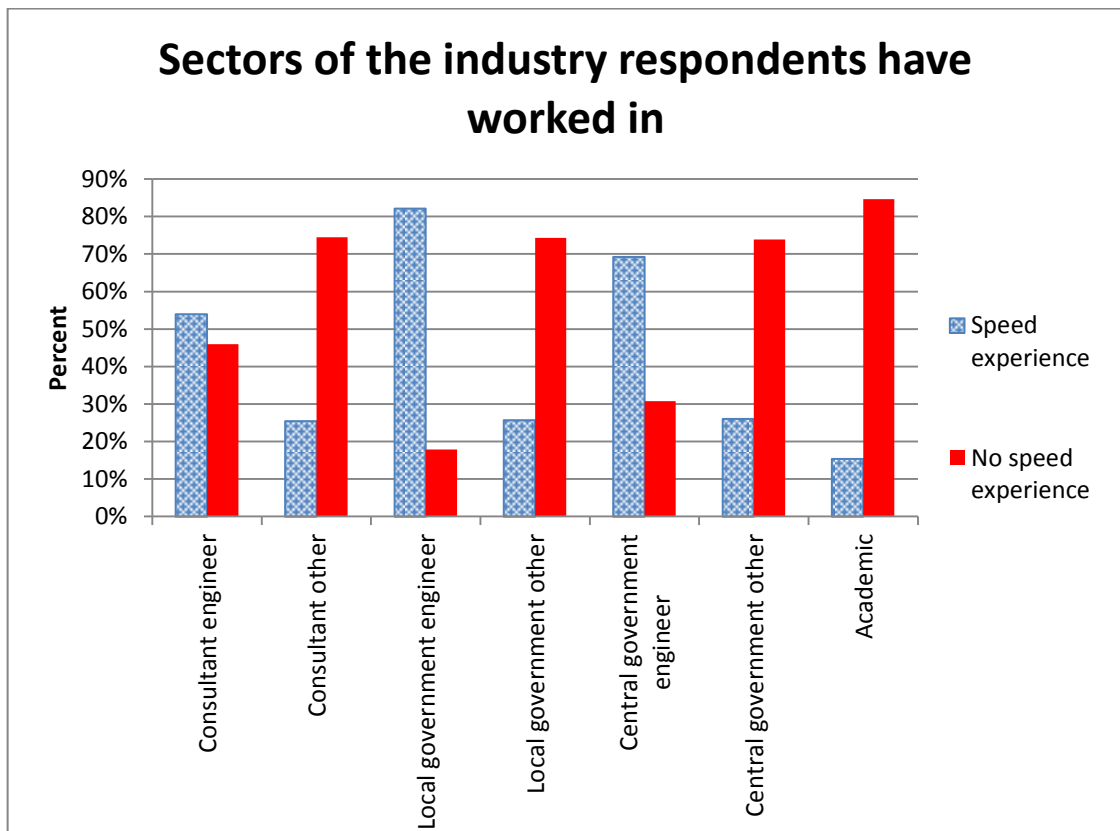


Figure 32: Sectors of the industry respondents with speed-related experience have worked in

Engineers were more likely to have had speed-related experience than planners. Respondents who had worked for local or central government were most likely to have speed-related experience.

The areas of sustainable land transport (question 2) that engineers and planners have worked in are shown in Figure 33.

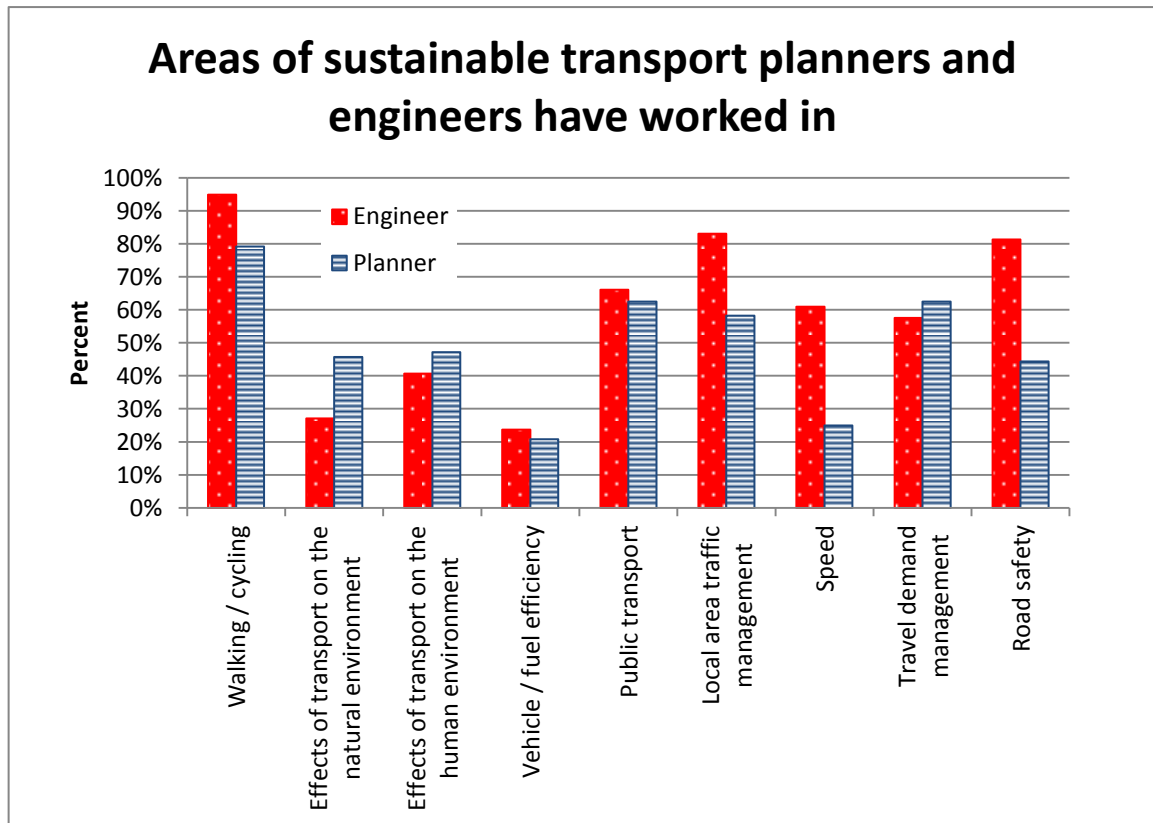


Figure 33: Areas of sustainable land transport by planners and engineers

Engineers were much more likely than planners to have been involved in road safety, speed, local area traffic management, and walking and cycling. Planners were however more likely to have been involved in considering the effects of transport on the natural environment.

Overall, analysis of questions 1-3 shows that respondents have a range of experience in terms of years of experience, involvement in speed-related work, and employment as an engineer or planner. These three aspects have been analysed as subgroups for questions 4-9 to identify any differences in opinions within the industry.

5.3.4 Question 4: effectiveness of methods

Question 4 asked respondents to assume the following sustainable transport methods had been implemented and to rate how effective, on a scale of 1 (very ineffective) to 7 (very effective), they thought each option would be at achieving sustainable land transport (i.e., objectives related to environmental sustainability, accessibility, public health, functional transport networks, economic development, integrated urban form, and safety).

- Walking / cycling infrastructure (e.g. cycle lanes, pedestrian refuge islands);

- Parking management (e.g. parking charges);
- Improved network efficiency / network management (e.g. road improvement projects to reduce congestion);
- Improved vehicle, fuel or energy efficiency standards (e.g. kilometres of travel per litre of petrol);
- Fuel or vehicle mileage taxes (e.g. road pricing);
- Improved public transport (e.g. reliability and frequency of buses, bus stops);
- Reduced urban speeds (e.g. to below 50 km/h);
- Travel Plans (e.g. to manage the amount of travel for a community or organisation);
- Law enforcement (e.g. of illegal parking across cycle lanes);
- Road safety improvements (e.g. physical changes to a road to reduce crashes);
- Advertising, education or awareness campaigns (e.g. awareness of travel alternatives).

Question 4 allowed respondents to provide a comment, 17 respondents commented on this question. Several noted that it was hard to rate responses given the effect on different objectives could be quite different. For example, it might be really effective at achieving environmental sustainability but really ineffective in terms of economic development. Several comments therefore noted that they had averaged their answer.

Several respondents also identified that it was difficult to assess these methods in isolation and / or that they should be implemented in a combined way. Others identified difficulty in determining the outcome due to a lack of clarity on how each method would be achieved, particularly in respect to flow on effects. For example, no road improvements could result in congestion eventually contributing to mode shift.

The average (mean) effectiveness rating is shown in Figure 34.

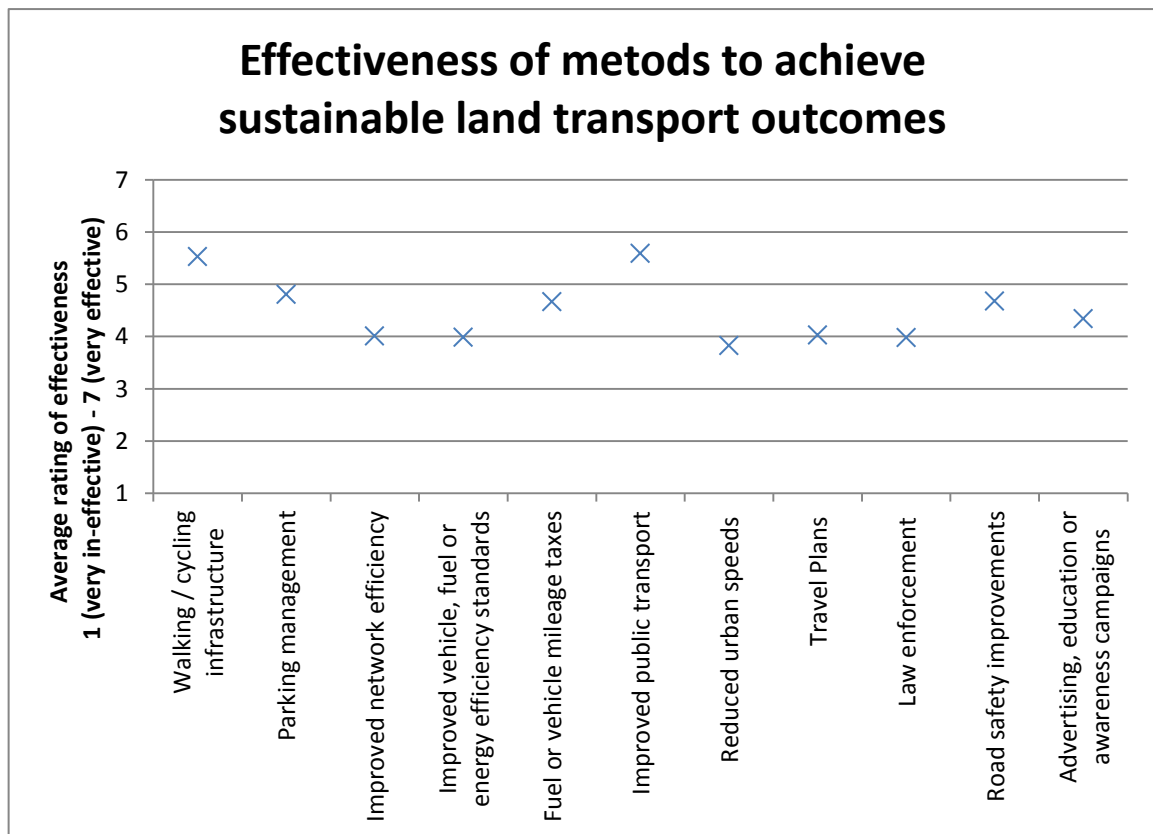


Figure 34: Average effectiveness of methods to achieve sustainable land transport

Based on the average rating shown in Figure 34, reduced urban speeds were considered to be the least effective of the listed methods. Improved network efficiency, improved vehicle, fuel or energy efficiency standards, travel plans, and law enforcement, all had a rating of approximately 4. This most likely represents either a neutral (neither effective nor ineffective) or uncertain response.

Walking and cycling infrastructure, and improved public transport, had average ratings which indicate that these methods would be effective. This was also evident in more detailed analysis of the spread of responses, shown in Appendix 4. This showed a skew towards the very effective end of the scale.

More detailed analysis of the spread of responses also highlighted a small degree of polarisation with respect to reduced urban speed, improved network efficiency, and travel plans. This indicates that there may be quite different views held by professionals within the industry.

A comparison of the average ratings for planners and engineers is shown in Figure 35.

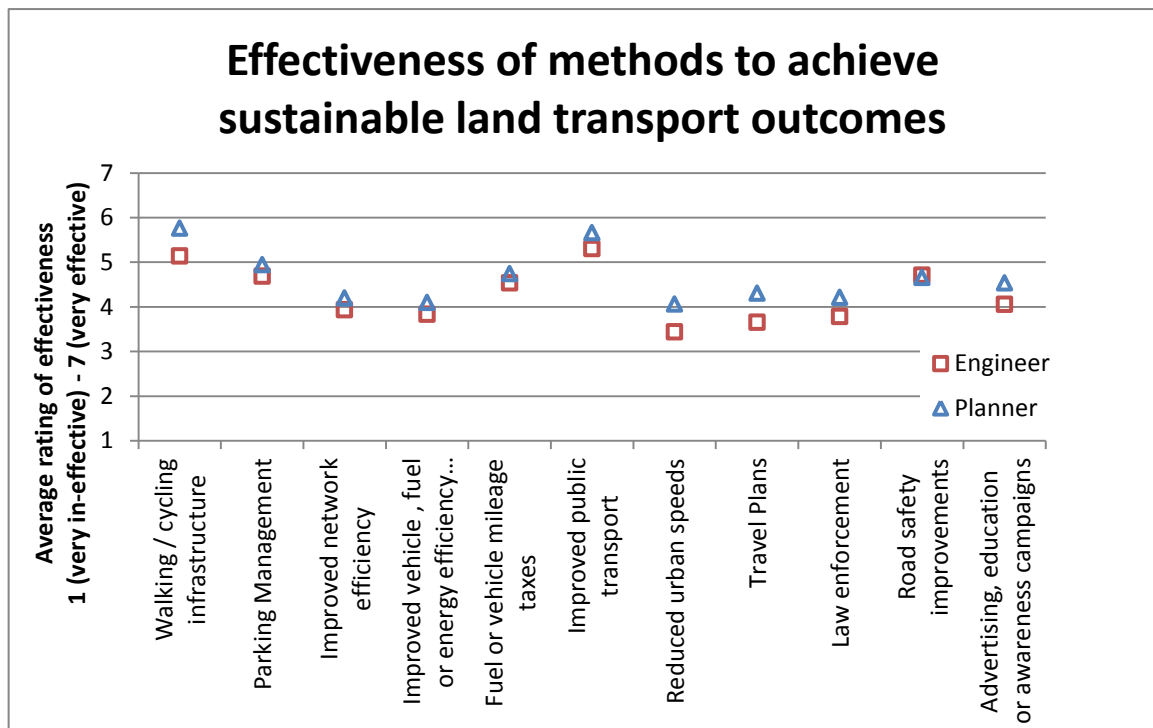


Figure 35: Average effectiveness rating of planners and engineers

The greatest difference between planners' and engineers' average ratings was in respect to travel plans, reduced urban speeds, and walking and cycling infrastructure. Planners gave a slightly more effective average rating than engineers for all methods, except road safety. The average rating for road safety was the same for both subgroups.

Comparison of average effectiveness ratings, by years of experience, is shown in Figure 36.

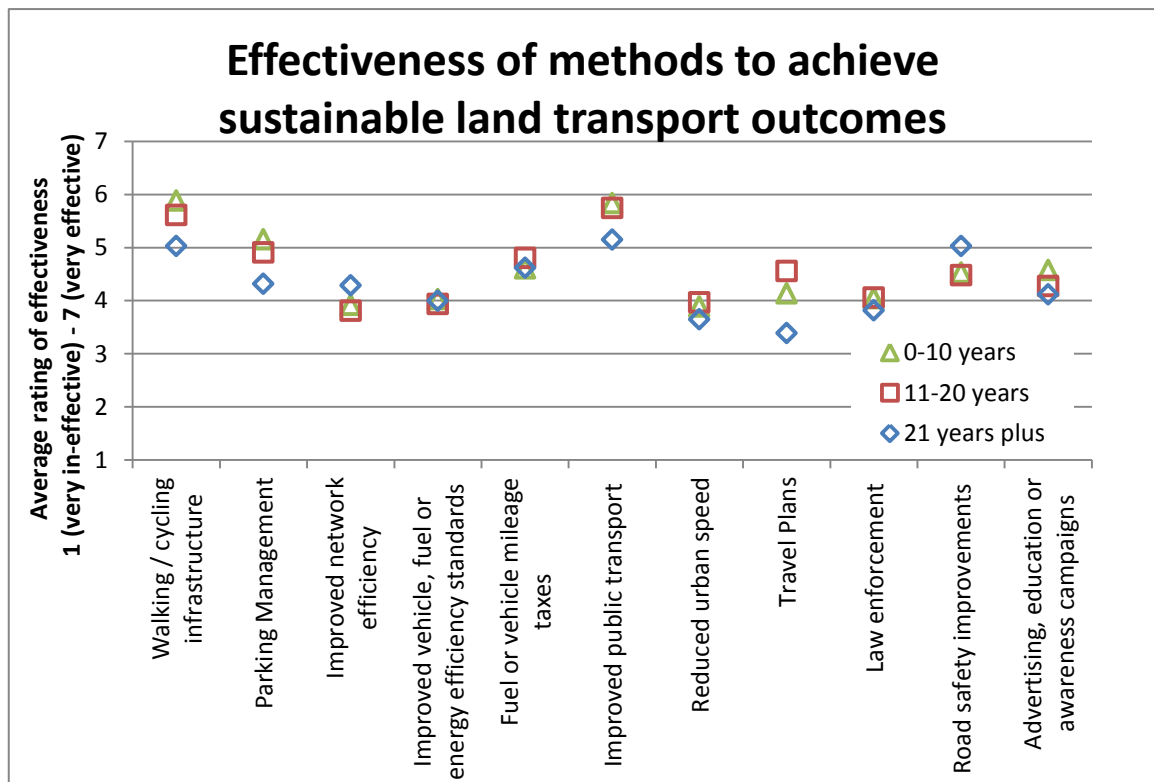


Figure 36: Average effectiveness rating by years of experience

The ‘21 years plus’ group generally gave the least effective average rating (for 7 out of the 11 methods). There was no clear trend between effectiveness ratings of the 0-10 years, and 11-20 years, of experience groups.

There was however a high degree of consistency between the ratings of each group for improved vehicle, fuel or energy efficiency standards, fuel or vehicle mileage taxes, reduced urban speeds, and law enforcement. The greatest difference between the average ratings was for the travel plans method. There was also notable variation in the average ratings of the walking and cycling infrastructure, parking management, and improved public transport methods.

Differences between respondents with and without speed-related experience are shown in Figure 37.

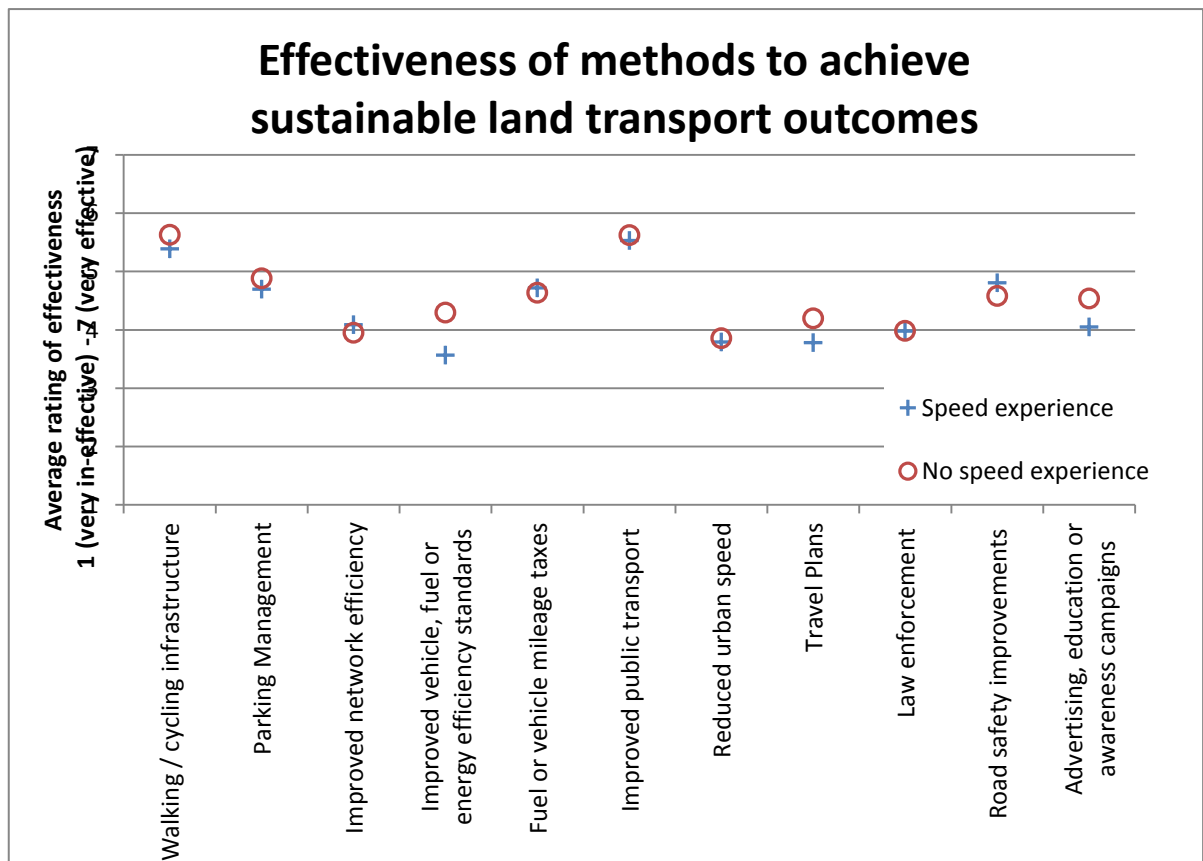


Figure 37: Average effectiveness rating, respondents with and without speed-related experience

There was no difference between respondents with and without speed-related experience in respect to law enforcement. Only the improving vehicle fuel or energy efficiency standards, travel plans, and advertising, education or awareness campaigns, showed any notable difference between the average ratings. In all three instances, those without speed-related experience gave a more effective rating. The differences between the average ratings were however fairly small.

There was little difference in opinion on reducing urban speeds between those with and without speed-related experience. This may reflect the limited exposure to reducing urban speeds even amongst those with speed-related experience, as their speed-related experience may be in other (for example peri-urban or rural) areas.

Overall, the analysis of question 4 indicates that respondents considered reducing urban speeds to be the least effective method to achieve sustainable land transport outcomes. There was a small degree of polarisation amongst responses, showing some diversity of opinion amongst professionals. Analysis of the subgroups suggested the greatest difference was

between planners and engineers. Planners considered reducing urban speeds would be more effective at achieving sustainable land transport outcomes than engineers.

Walking and cycling infrastructure, and public transport improvements, were considered the most effective methods to achieve sustainable land transport objectives. In terms of subgroup trends, planners generally gave more effective ratings. Respondents with more than 21 years experience generally gave a less effective rating for the different methods.

The majority (8 out of the 10) of the other methods were however considered to be more easily achievable than reducing urban speeds.

5.3.5 Question 5: achievability of methods

Question five asked respondents to rate how achievable the methods would be to implement in urban areas of New Zealand (i.e., considering current political and public opinions, and practical and technical aspects of implementation). They were asked to rate the same methods listed in question 4, on a scale of 1 (very difficult) to 7 (very easy).

Question five allowed respondents to comment. Many respondents thought that implementation needed to consider funding as well. Some respondents also noted that it depended on local issues. One respondent noted the current change in priorities towards economic growth and productivity, value for money, and road safety. Another commented that experience in Hamilton showed that it was relatively easy to make changes with commitment from local government.

The average rating for each method is shown in Figure 38.

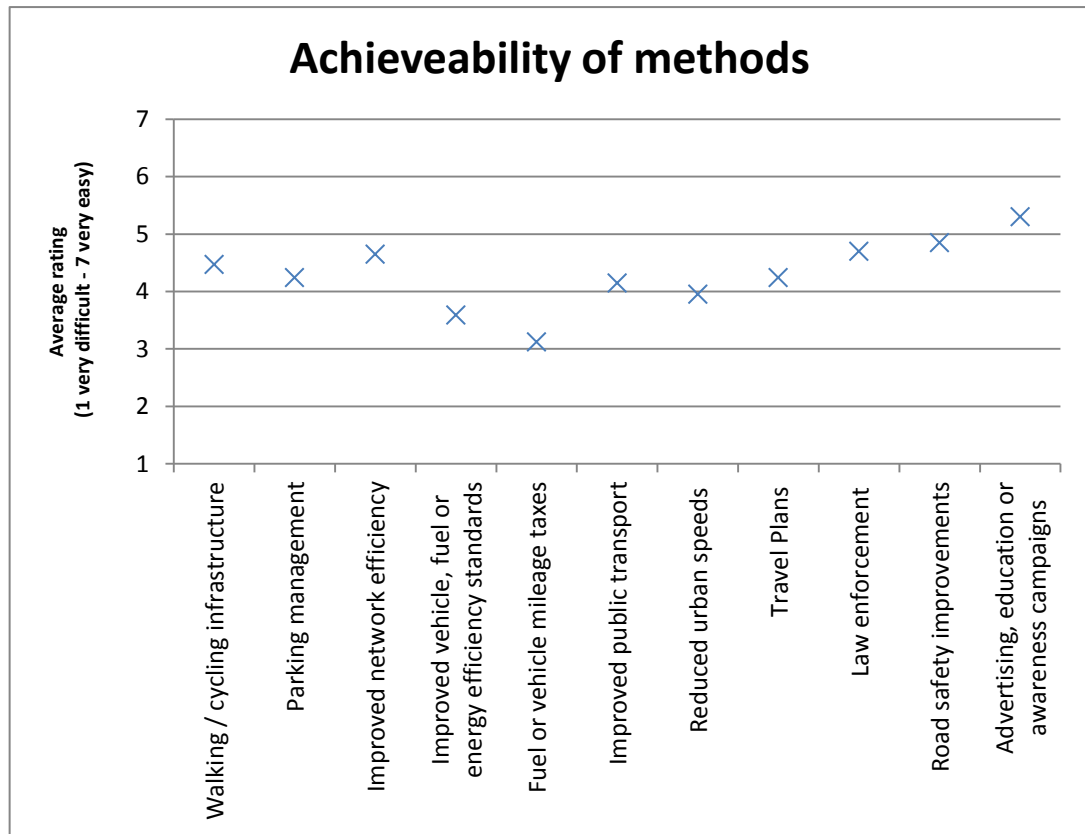


Figure 38: Average rating of achievability

The average ratings were either neutral or within one increment of neutral for all methods except advertising, education and awareness campaigns. Most of the near neutral average ratings fell slightly towards the ‘easy’ side of the scale. The more detailed analysis (refer to Appendix 5) indicated that most of the responses were slightly towards the easy end of the scale. The more detailed analysis also showed that travel plans, law enforcement, and reducing urban speeds, had the greatest range of views, and showed a small degree of polarisation in the ratings given.

The average rating for improving vehicle, fuel or energy efficiency standards, and fuel or vehicle mileage tax methods, fell towards the difficult side of neutral and this was also reflected in the spread of responses, which both trended towards the difficult end of the scale.

Comparison of the average ratings between planners and engineers, showed a negligible difference in opinion between these two groups as shown in Figure 39.

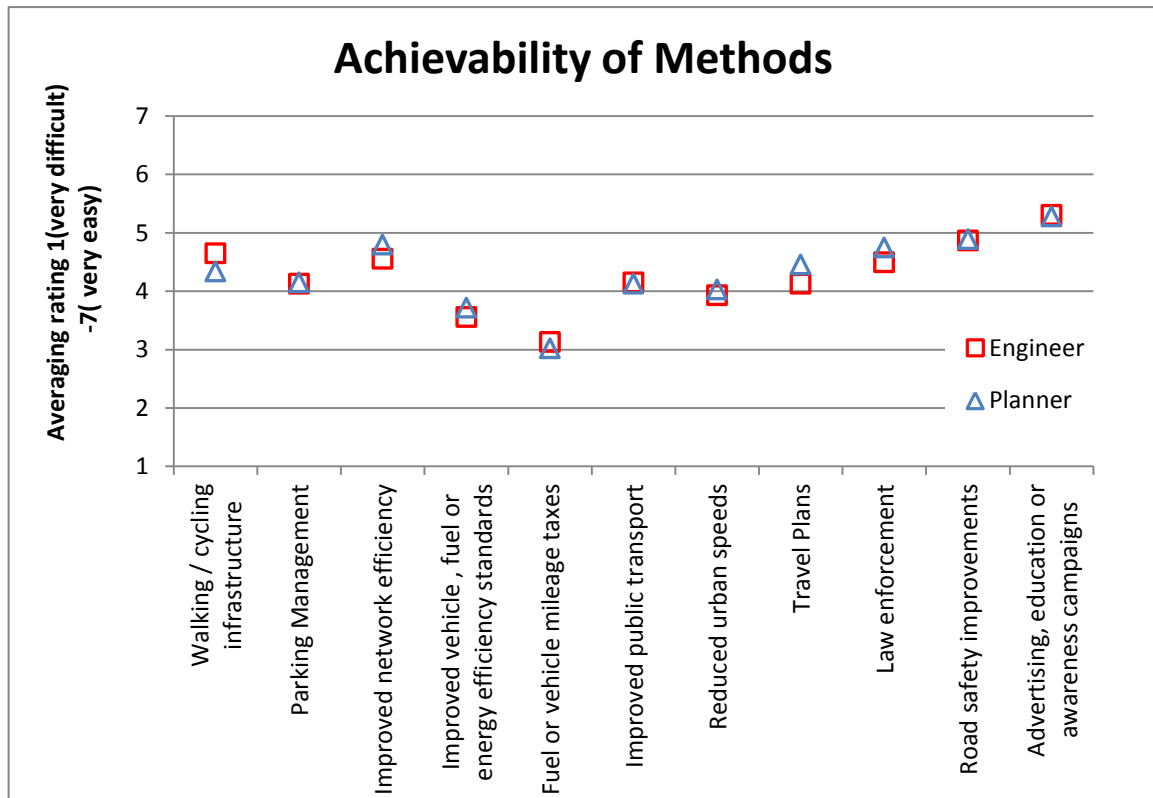


Figure 39: Average rating of achievability, engineers and planners

The average rating for each method by years of experience is shown in Figure 40.

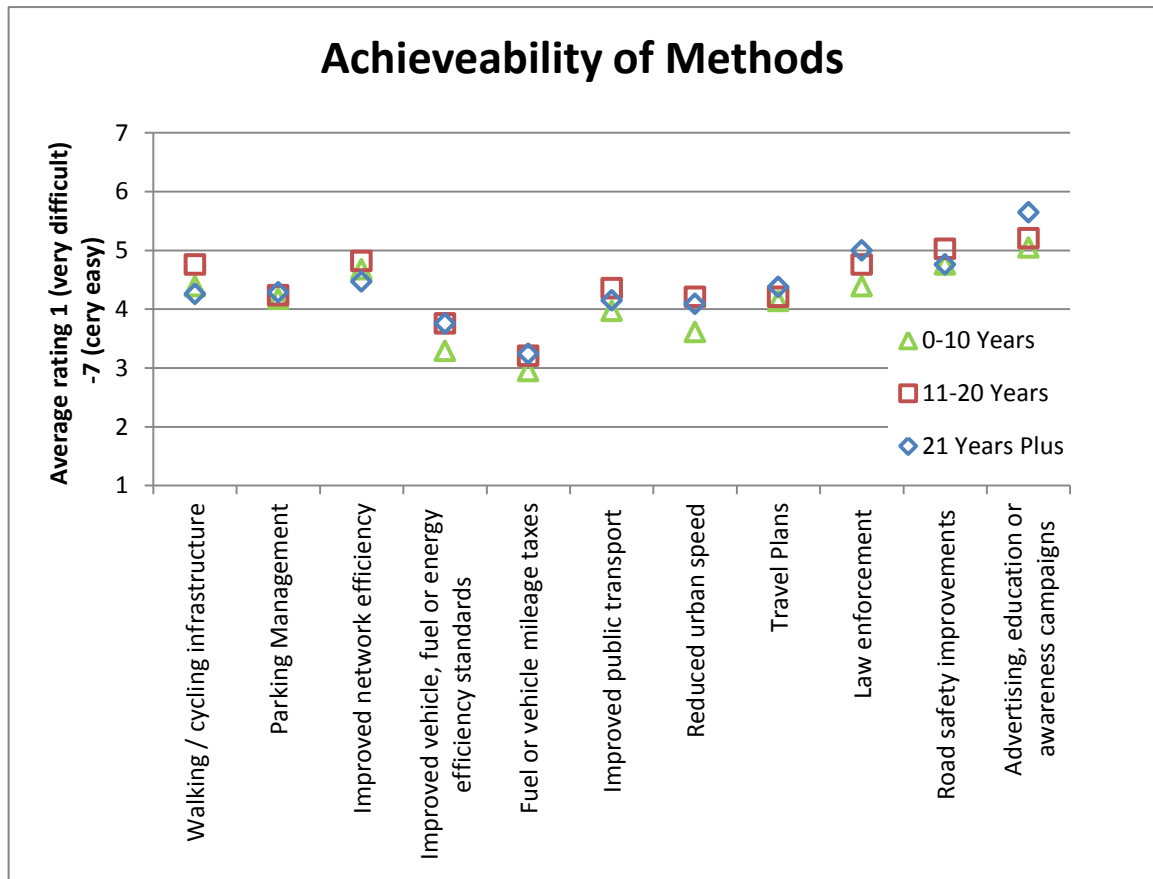


Figure 40: Average rating of achievability by years of experience

Comparisons of the average ratings by years of experience, showed a high degree of consistency in respect to parking management, travel plans, fuel or vehicle mileage taxes, and road safety improvements. Reduced urban speeds, law enforcement, and advertising, education and awareness campaigns, had the greatest variation in average ratings. Generally respondents with 0-10 years of experience had the lowest average rating, with the exception being walking and cycling, and improved network efficiency, where the 21 plus years of experience gave the lowest average rating in both instances.

The difference in average ratings between those with and without speed-related experience is shown in Figure 41.

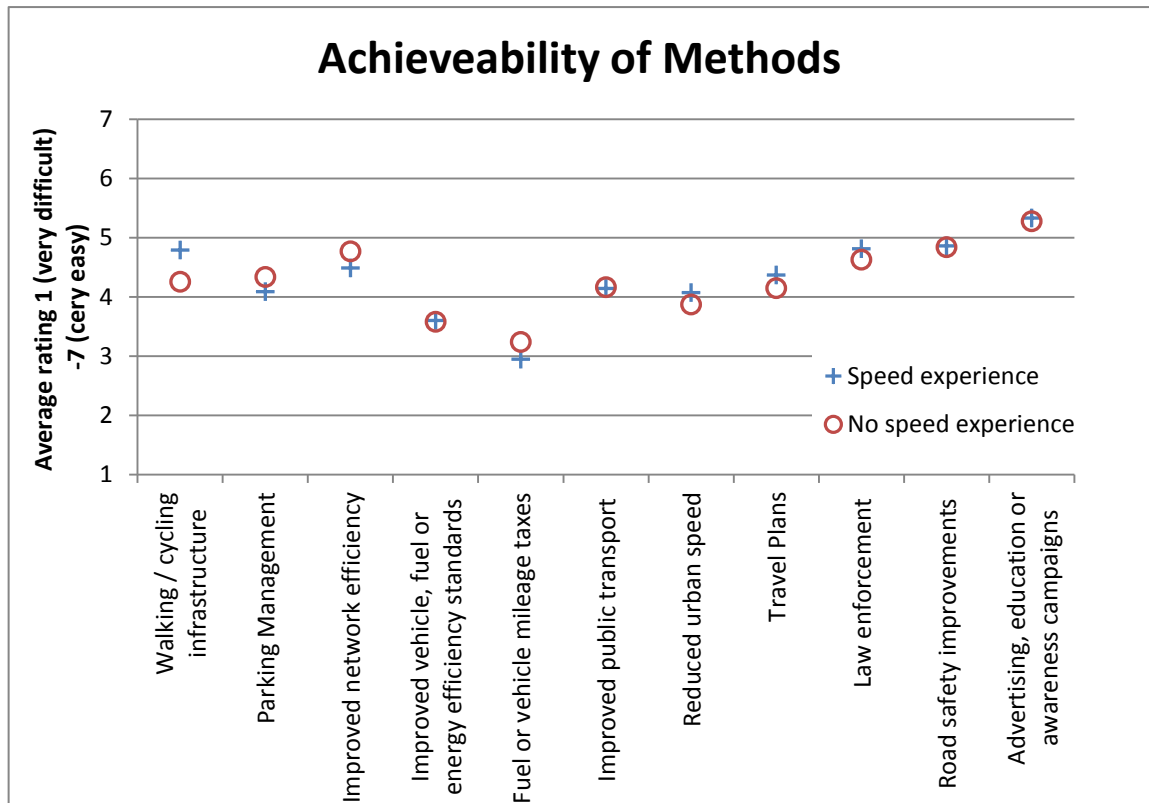


Figure 41: Average rating of achievability respondents with and without speed-related experience

The greatest difference in average ratings between those with and without speed-related experience was for walking and cycling infrastructure. There was very little difference in the average ratings between those with and without speed-related experience for the improved vehicle, fuel or energy efficiency standards, improved public transport, road safety, and advertising, education or awareness campaigns methods.

Overall in respect to question 5, reducing urban speeds was considered neither easy nor difficult to implement. There was however a small degree of polarisation; respondents with 0-10 years experience generally considered it was less achievable than those with more experience. There was reasonable consistency in the average ratings for the other subgroups analysed.

Advertising, education or awareness campaigns, were considered to be the easiest to implement and fuel or vehicle mileage taxes, the most difficult. Generally respondents with 0-10 years experience gave less achievable ratings, than those with more experience, whilst those with speed-related experience considered the methods easier to implement than those

with no speed-related experience. There was no clear difference between the responses of planners and engineers.

5.3.6 *Question 6: impact of reducing urban speed*

Question 6 asked respondents to consider the policy of reducing urban speeds to below 50 km/h (noting that it could be achieved by a variety of methods such as speed limits and / or physical measures). They were asked to rate, on a scale of 1 (worsen) to 7 (improve), how they thought reducing urban speeds (to below 50 km/h), could affect each of the following outcomes:

- Crash severity (less severe = improved);
- Number of motor vehicle crashes (less crashes = improved);
- Number of crashes involving cyclists or pedestrians (less crashes = improved);
- Number of incidents of crime / feeling of insecurity (less incidents = improved);
- Level of vehicle emissions (less emissions = improved);
- Fuel usage of vehicle (less fuel per kilometre of travel = improved);
- Amount of traffic generated vibrations / noise (less vibrations / noise = improved);
- Number of people choosing to drive rather than walk or cycle (less people driving = improved);
- Amenity (more pleasant = improved);
- Travel Time (less time to undertake a journey = improved);
- Travel Choices (more choices = improved).

Generally the options were worded such that less represented an improvement however it was highlighted to respondents that the reverse occurred for the last three outcomes.

There were 15 comments on this question, which indicated:

- A view that strategically placed speed limits are more effective than reducing speed everywhere.

- Uncertainty over what is meant by vehicle emissions (greenhouse gas may be different to air quality).
- Mode split may not change but destination may.
- Uncertainty about the impact on crime (some felt a not applicable answer was required for this option).

The average ratings are shown in Figure 42 below.

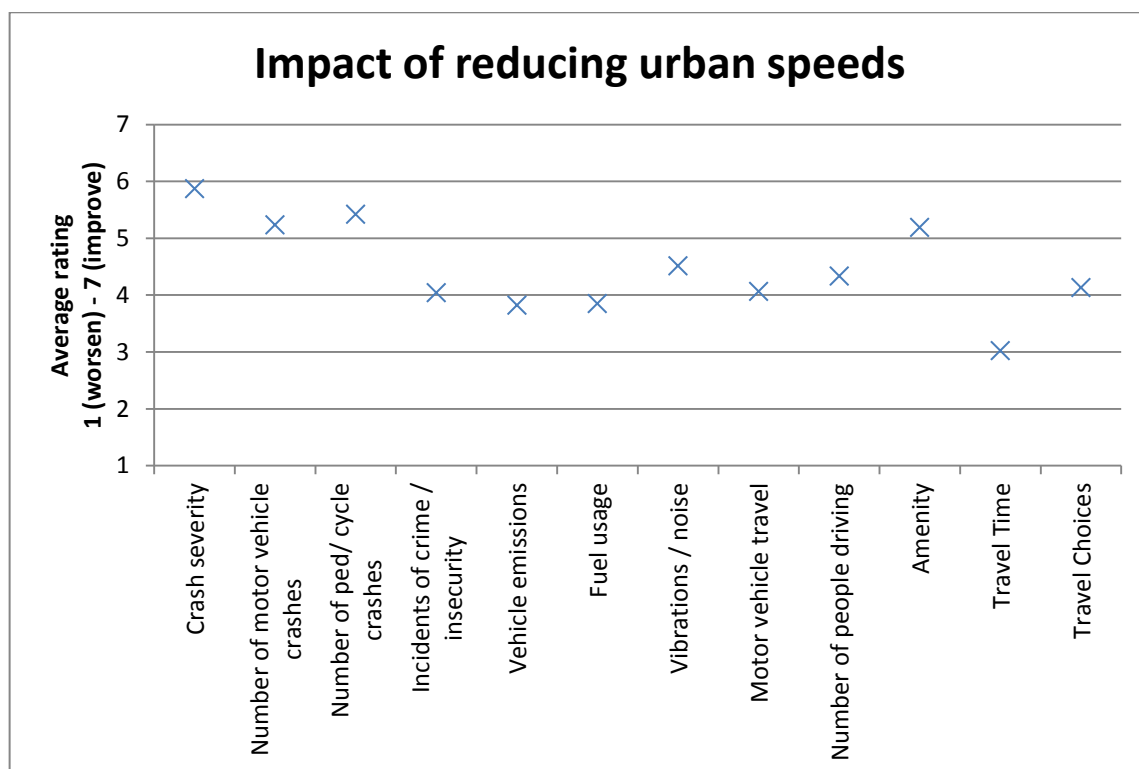


Figure 42: Impact of reducing urban speeds

The most positive impacts related to amenity, and the three safety-related outcomes (crash severity, number motor vehicle crashes and number of pedestrian and cycle crashes). The most negative impact related to travel time.

The average ratings for the other outcomes were all reasonably neutral. Analysis of the spread of responses indicated a wide range of views, in respect to: the impact on vibrations and noise, number of people choosing to drive, fuel usage, and level of vehicle emissions.

There was a much greater neutral response in respect to travel choices, amount of motor vehicle travel and the number of incidents of crime. When considered in conjunction with

the comments, this may reflect a “don’t know” or “not applicable” response in respect to these three outcomes. The spread of responses is shown in Appendix 6.

Comparison of the average ratings of planners and engineers, for each outcome, is shown in Figure 43.

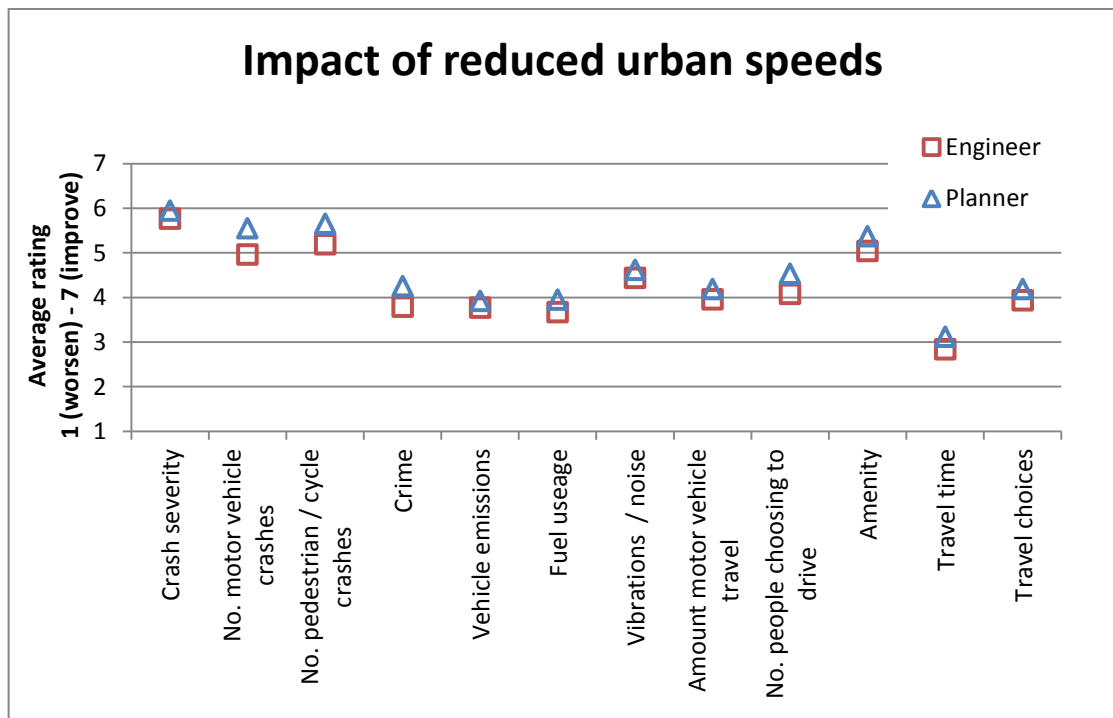


Figure 43: Impact of reducing urban speeds; planners and engineers

The average rating was higher for planners than engineers for all outcomes. In most instances, the difference was very small and there was reasonable consistency in respect to the average ratings. The greatest difference in ratings was for the number of motor vehicle crashes, number of crashes involving pedestrians or cyclists, incidents of crime, and the number of people choosing to drive.

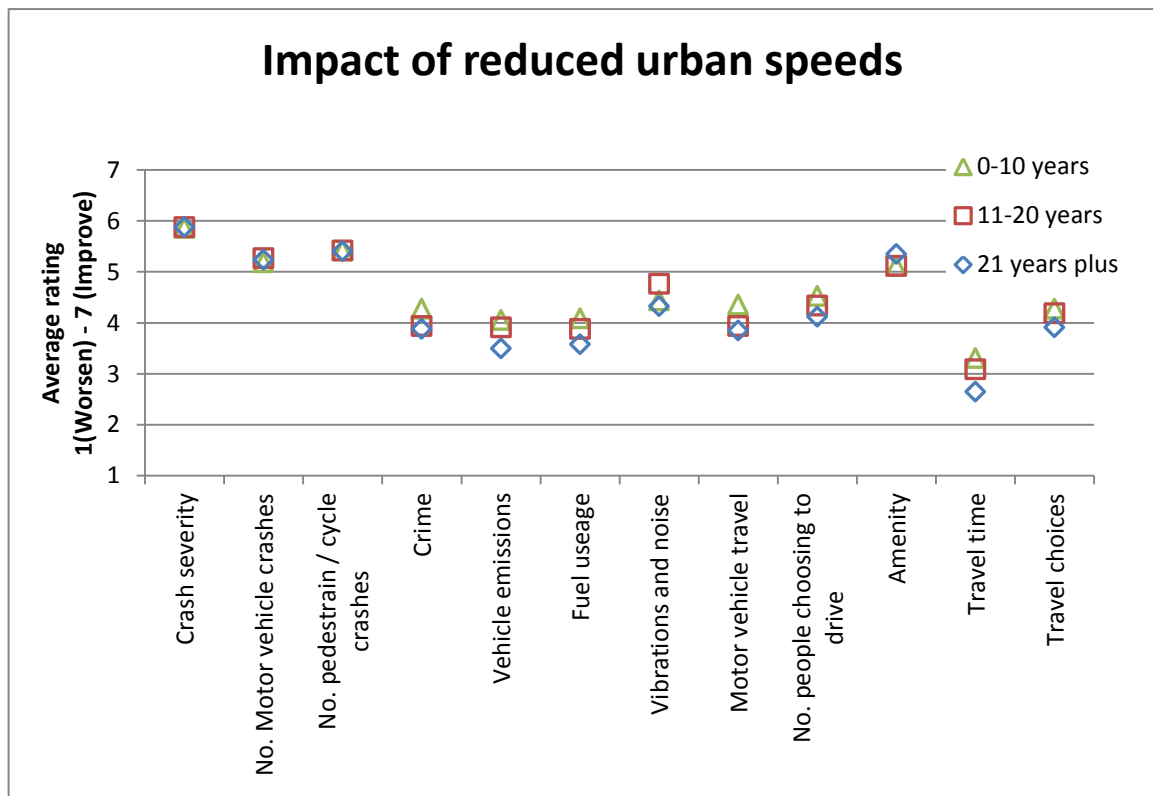


Figure 44: Impact of reducing urban speeds by years of experience

Generally, respondents with 0-10 years experience, gave the highest average rating (8 out of 12 outcomes) and respondents with 21 years plus experience, gave the lowest rating (9 out of 12 outcomes).

There was a high degree of consistency in the average ratings for the three crash-related outcomes. The greatest variation in average ratings was for vehicle emissions, fuel usage, motor vehicle travel, and travel time.

Comparison between the average rating of respondents with and without speed-related experience is shown in Figure 45.

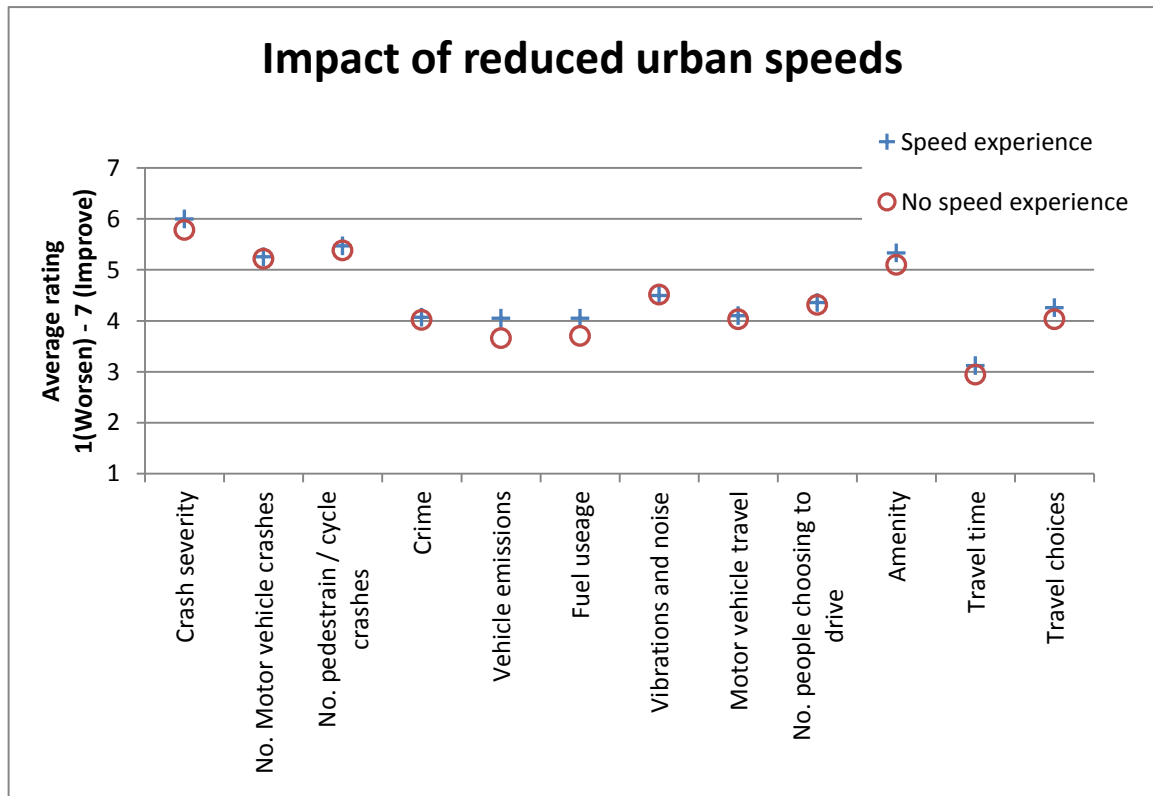


Figure 45: Impact of reducing urban speeds, speed and no speed-related experience

There was generally little difference between the average ratings of those with and without speed-related experience. The greatest difference was for vehicle emissions and fuel usage. Although the difference in average ratings was very small, it was noted that those with speed-related experience gave a more positive average rating for all outcomes, except vibrations and noise.

Overall, respondents considered the greatest improvements would occur in terms of amenity and safety. The greatest impact was considered to be increased travel times. There was a range of views amongst respondents on the impact on vibrations and noise, and motor vehicle travel, particularly by years of experience.

The average ratings of engineers and planners, and those with and without speed-related experience, were reasonably consistent. Planners and those with speed-related experience however generally gave slightly more positive (likely to improve or not so likely to worsen) ratings.

Those with less experience (0-10 years) were more likely to give the most positive rating and those with the most experience (21 years plus) were most likely to give less positive ratings.

5.3.7 Question 7: factors influencing urban speed reduction

Question 7 asked respondents to rate (from 1 restrict to 7 facilitate) the following factors in terms of how much they thought they may currently restrict or facilitate, the achievement of reduced urban speeds (speeds below 50 km/h) in New Zealand:

- Political opinion;
- Residents' opinion;
- Public opinion (generally i.e., other than immediate residents);
- Enforceability of reduced speeds;
- Ability to monitor changes / effects;
- Cost / budgets;
- Time;
- Expertise / industry knowledge;
- Legislation.

Comments on this question suggested that answers would differ for just local roads or on roads with high pedestrian and cyclist numbers. Some respondents noted that current speed limit legislation is cumbersome and time consuming as changing speed limits would require changes to bylaws and community consultation. It was also noted that there was some support for reducing speeds if the effectiveness can be monitored to show a reduction in crashes, but it was noted that a vocal minority can outweigh overall support.

The average rating for each factor is shown in Figure 46.

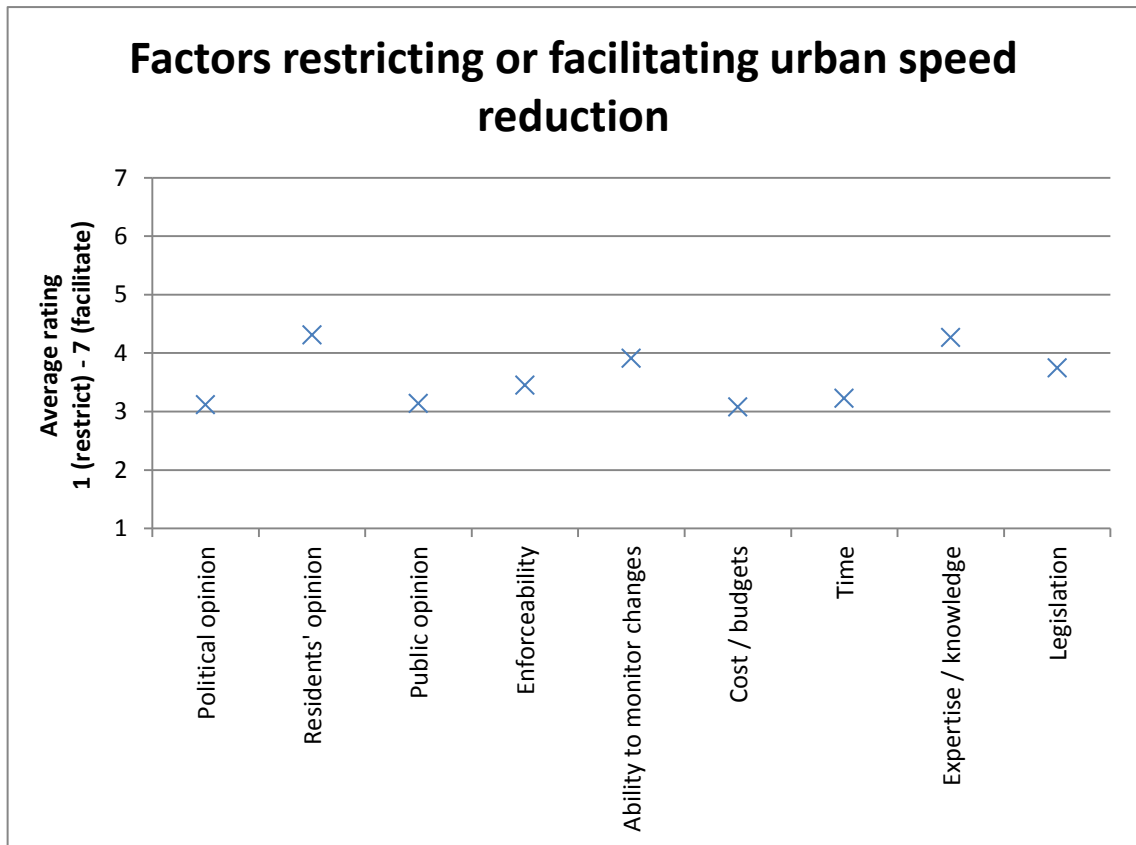


Figure 46: Average rating of factors restricting or facilitating urban speed reduction

Only residents' opinion and expertise / knowledge were considered to facilitate achieving reduced urban speeds and this was to a small degree. Political opinion, public opinion and cost / budgets were considered to be the most restrictive factors. Legislation, time, and enforceability, were also considered to slightly restrict the achievement of reduced urban speeds. The ability to monitor changes was considered to have little impact.

More detailed analysis of the spread of results (refer to Appendix 7) indicated a small degree of polarisation in respect to legislation and residents' opinion.

Comparison of the average ratings of engineers and planners is shown in Figure 47.

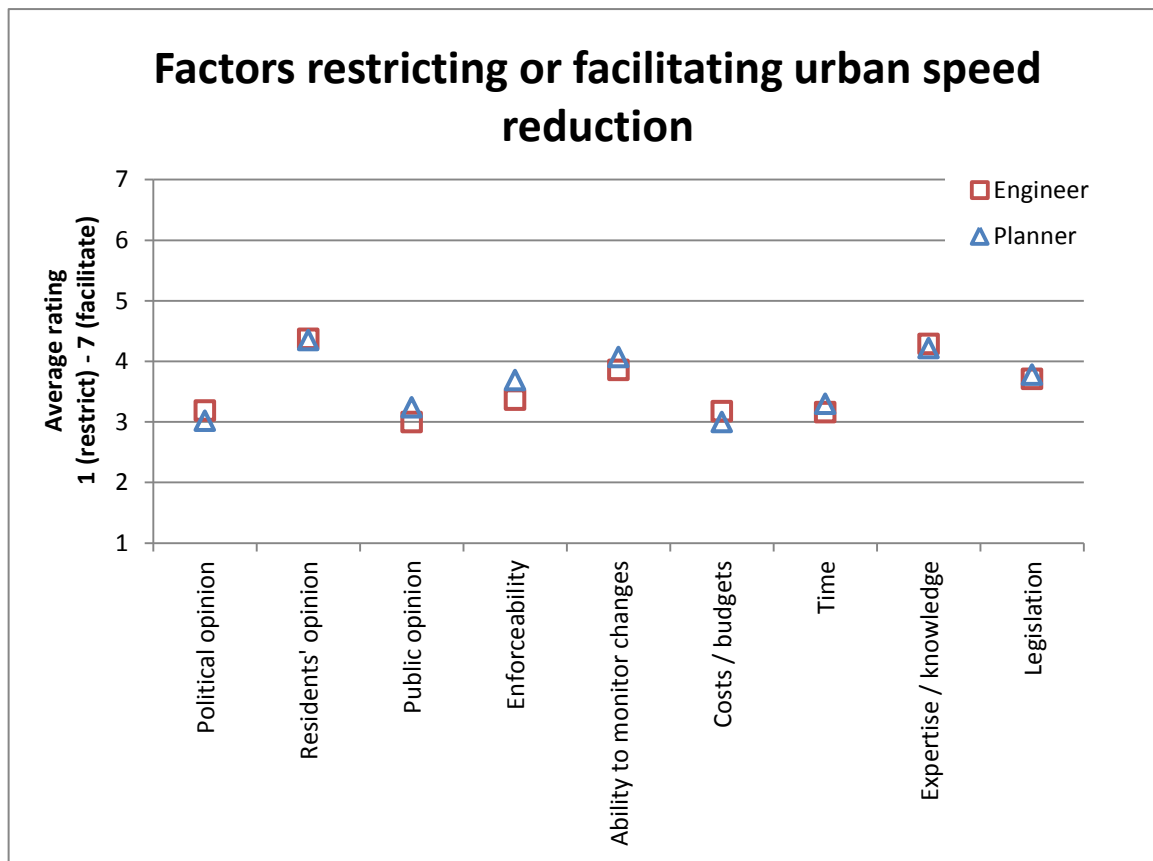


Figure 47: Average rating of factors restricting or facilitating urban speed reduction, planners and engineers

There was very little difference in the average ratings between planners and engineers. The greatest difference in ratings was for public opinion, enforceability, and ability to monitor changes. Planners gave a slightly higher average rating in all three instances. There was however no overall trend towards a higher average rating by planners.

A greater difference in average ratings is present between groups with different years of experience in the industry, as shown in Figure 48.

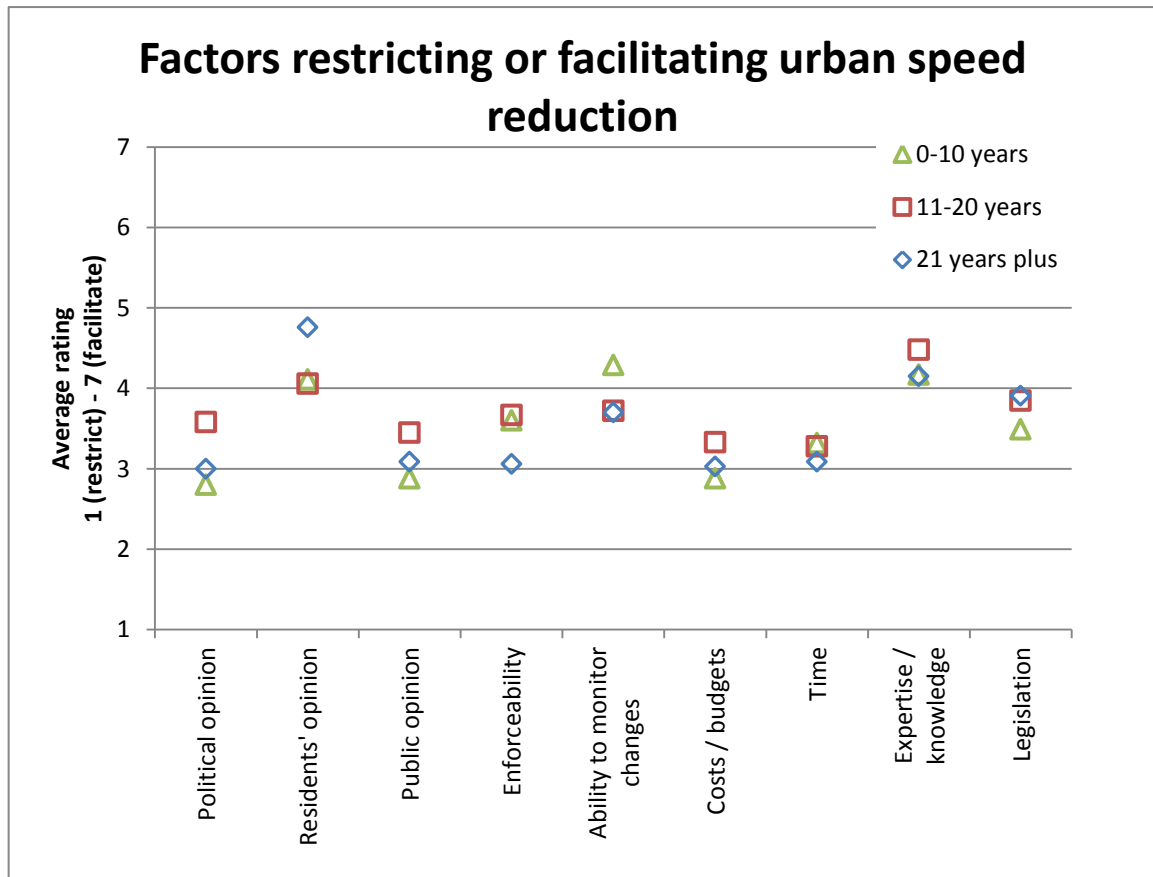


Figure 48: Average rating of factors restricting or facilitating urban speed reduction by years of experience

There is a noticeable although not large, difference in average ratings for different levels of experience, for all factors, except time. There were no clear trends in terms of higher or lower ratings by any one group.

A comparison of those with and without speed-related experience is shown in Figure 49.

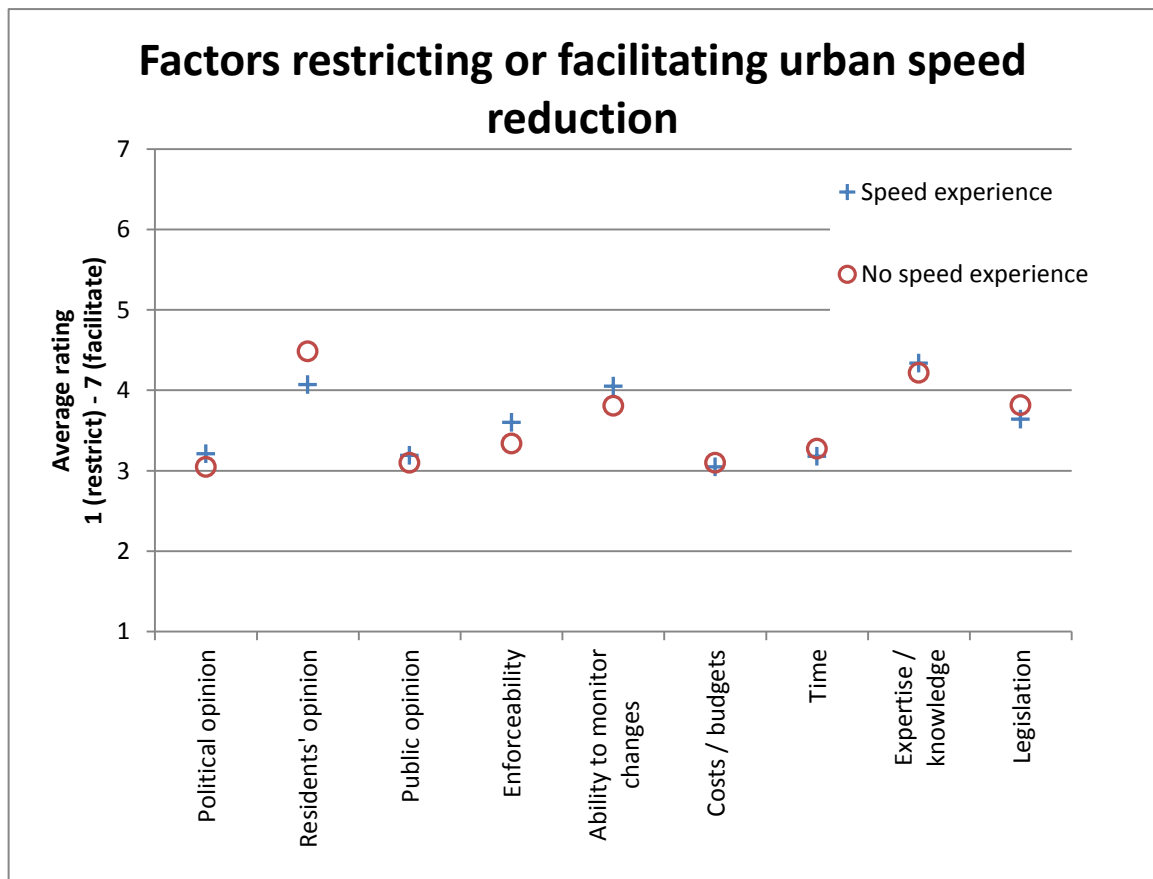


Figure 49: Average rating of factors restricting or facilitating urban speed reduction, respondents with and without speed-related experience

The greatest difference in average rating between those with and without speed-related experience, was in respect to residents' opinion. Those without speed-related experience gave a more positive (facilitate) average rating. There was also a notable difference between the average ratings for enforceability and the ability to monitor changes. The least difference was in respect to the average rating for costs and budgets.

Overall, only residents' opinions, and expertise / knowledge, were considered likely to facilitate achieving reduced urban speeds. In some respects, given the limited number of low speed areas implemented in New Zealand, it is surprising that expertise / knowledge was considered to facilitate achieving reduced urban speeds.

Political opinion, public opinion and costs / budgets were considered most likely to restrict the achievement of reduced urban speeds. The average ratings varied most by years of experience however there were no clear trends. Planners and engineers and those with and

without speed-related experience gave reasonably consistent ratings. The greatest variability in average rating was for public opinion, enforceability, and ability to monitor changes.

Overall, the generally pessimistic outlook on the impact of these factors is not entirely unsurprising given the limited number of low speed areas implemented in New Zealand.

5.3.8 Question 8: contribution to sustainable land transport

Question 8 asked respondents whether they considered reducing urban speeds, to less than 50 km/h, would contribute to more sustainable land transport. Rather than the 7 point scale used in question 4, respondents were given five options (definitely will, probably will, unsure, probably won't and definitely won't). The results are shown in Figure 50.

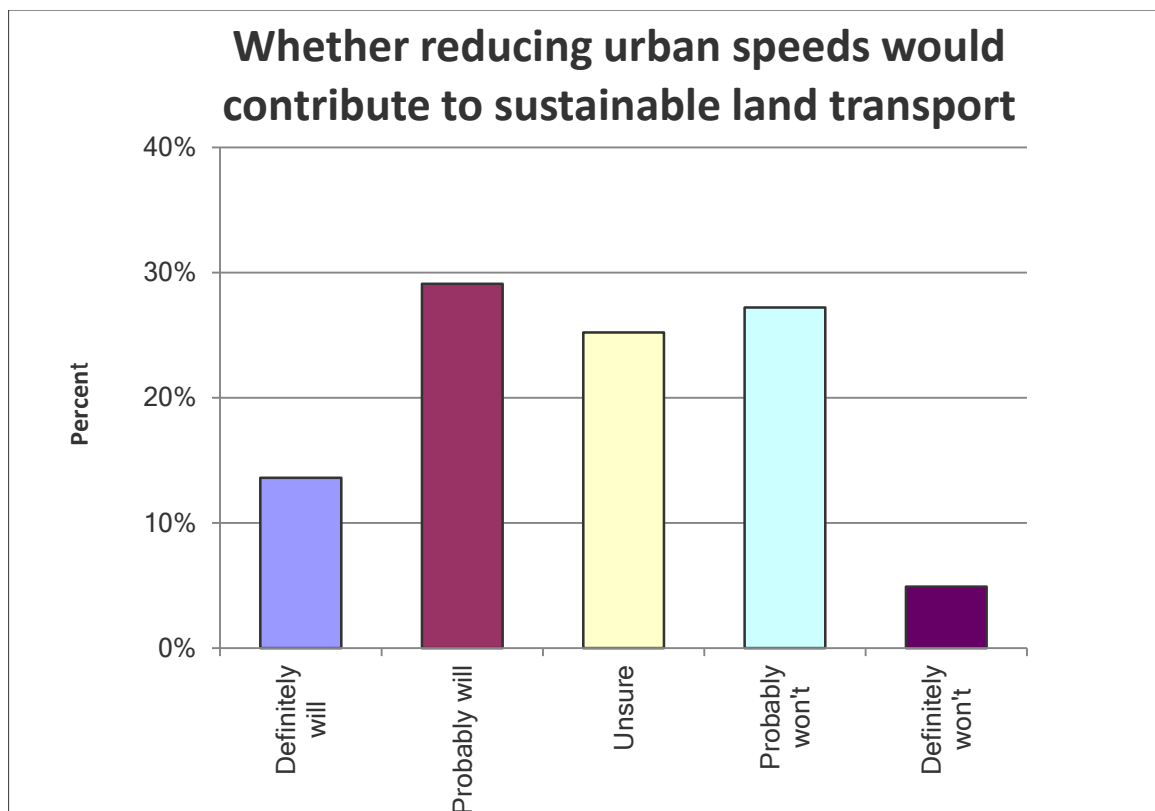


Figure 50: Whether reducing urban speeds will contribute to more sustainable land transport

In total, 43% of respondents thought that reducing urban speeds would contribute to more sustainable land transport, 32% thought that it would not and the remainder (25%) were unsure.

To provide a greater insight into the reasons for this response the question also asked respondents to explain their choice. Some of the main themes were:

- Reducing speeds in isolation would not achieve these objectives and a combination (package) approach is required. For example, there may be no change because there is a lack of public transport options.
- Reducing speeds will improve only safety and won't achieve all the objectives of sustainable land transport. There are other reasons (no examples stated) for reducing speeds other than to achieve sustainable land transport.
- It depends on how it is achieved, what speed is chosen (30 km/h or 40 km/h), and where and over what timeframe.
- There is a need to address public opinion and mind-sets (lower speeds may frustrate motorists and the "car culture" is not likely to be changed by reduced speeds).
- Improves relative attractiveness (including safety) of walking and cycling.
- Lowering speeds on arterials may be detrimental, and dis-benefits will outweigh benefits (e.g. increased travel time and fuel efficiency is best at about 70 km/h).
- Lack of enforcement may undermine the ability to achieve lower speeds (for example, the Ponsonby Road 40 km/h speed limit is not being enforced).
- Speeds in some areas are already low (for example, in a CBD due to congestion).

The comments reflect respondents' wide range of opinions and difficulty in weighing up benefits and dis-benefits.

There was a noticeable difference in opinion between planners and engineers as shown in Figure 51.

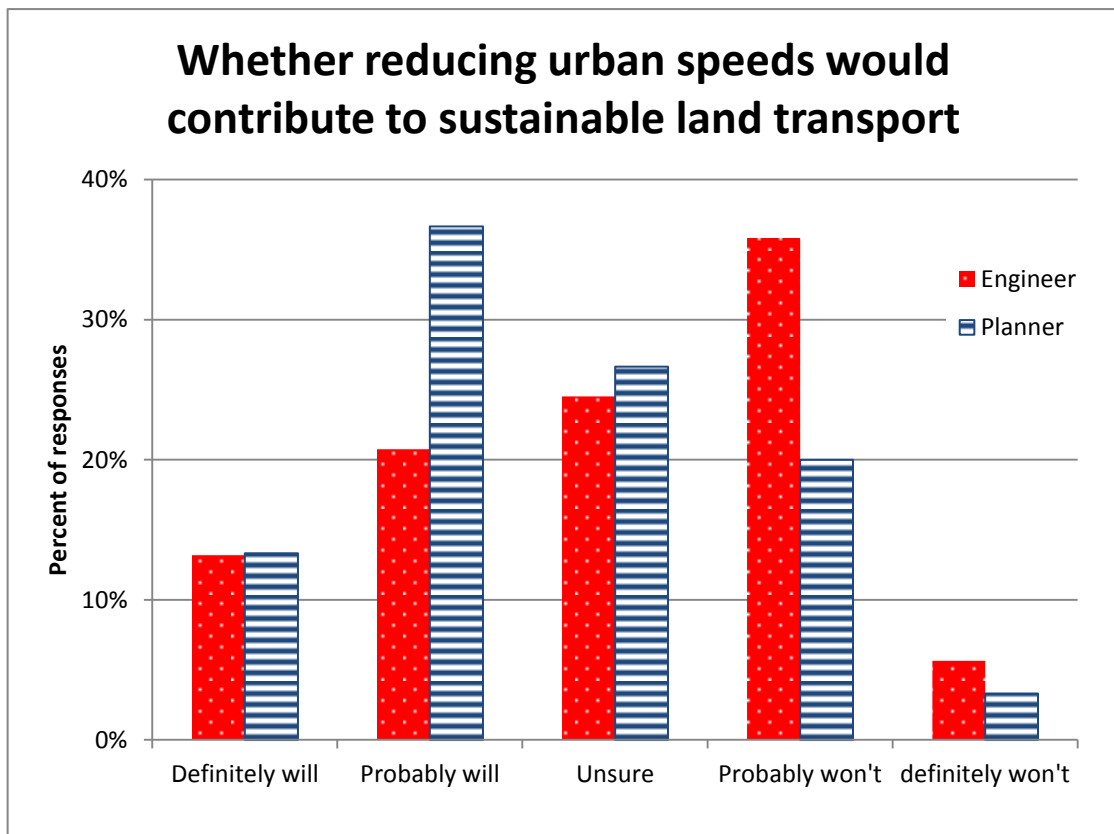


Figure 51: Whether reducing urban speeds will contribute to more sustainable land transport, planners and engineers

Planners were more likely to consider that reducing urban speeds would contribute to sustainable land transport outcomes (50% of responses) than engineers (34% of responses). Engineers were more likely to consider that it would not contribute to sustainable land transport outcomes (42%) than planners (23%). The spread of responses reflected these trends. The responses reflect the trends identified in questions 4 and 6, where planners generally gave a slightly more positive rating. It is however noted that for both groups, the proportion of responses which considered it definitely would contribute, was more than double that which through it definitely wouldn't.

Comparison of the responses by years of experience is shown in Figure 52.

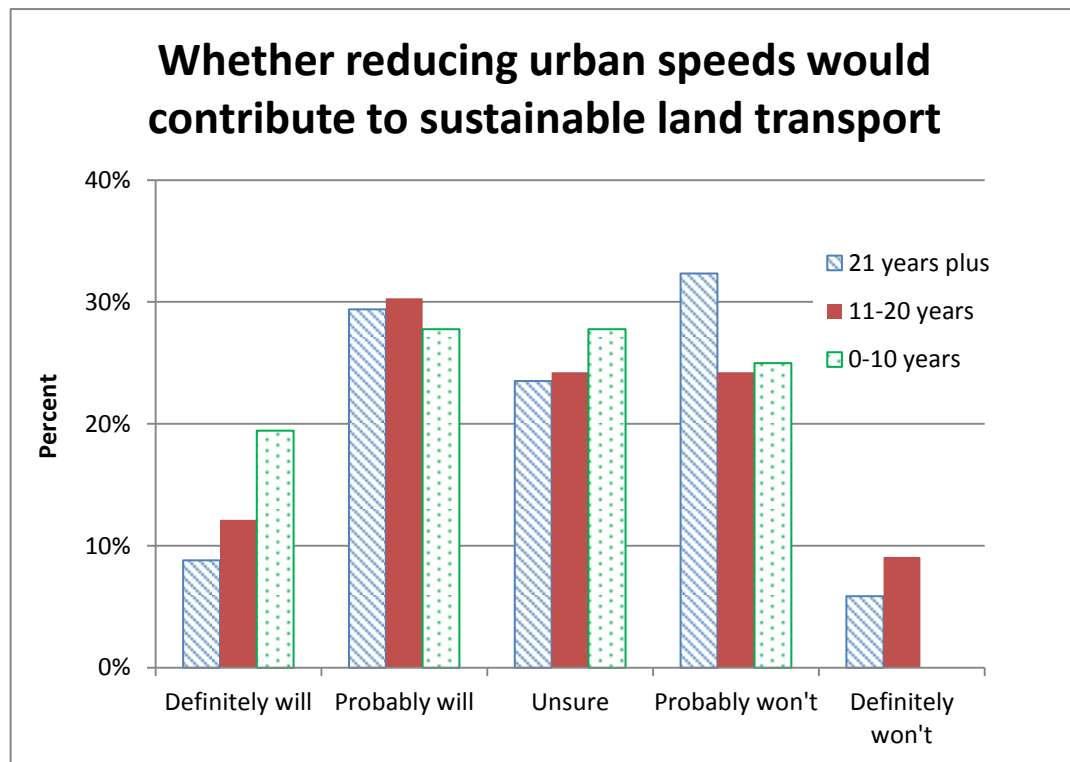


Figure 52: Whether reducing urban speeds will contribute to sustainable land transport by years of experience

The 0-10 and 11-20 years experience groups considered that reducing urban speeds would contribute to sustainable land transport (47% would versus 25% wouldn't for 0-10 years, and 42% would versus 33% wouldn't for the 11-20 years group). The 21 years plus group was evenly split (38% thought reducing urban speeds would and 38% thought it wouldn't). All groups answered slightly higher in the 'definitely will' than 'definitely won't' options. Notably, none of the respondents with 0-10 years experience selected the 'definitely won't' option.

Comparison of responses between those with and without speed-related experience is shown in Figure 53.

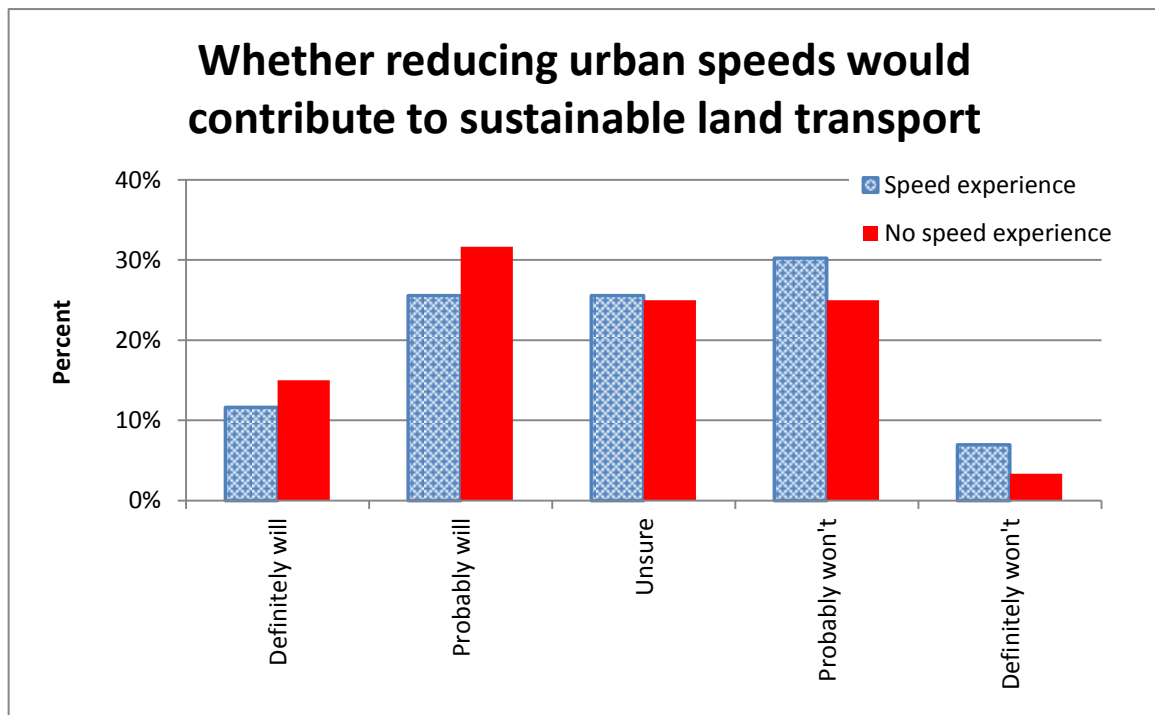


Figure 53: Whether reducing urban speeds will contribute to sustainable land transport, speed and no speed-related experience

Those without speed-related experience were more likely to consider that it would contribute towards sustainable land transport. Those with speed-related experience were evenly divided (between would and wouldn't contribute).

Overall, it is concluded that, industry professionals have a range of views, on whether reduced urban speeds would contribute to sustainable land transport, but the proportion that consider it would contribute (48%) outweigh those that thought it wouldn't (32%). Respondents with 0-20 years experience, and respondents with no speed-related experience, were more likely to consider that it would contribute to sustainable land transport.

There was a noticeable difference in opinion between planners and engineers. Planners were generally more likely to consider that it would contribute to sustainable land transport outcomes (50% considered it would, 23% considered it wouldn't) than engineers (34% considered it would, 42% considered it wouldn't). This also reflects the more positive responses by planners to questions 4 and 6.

5.3.9 Question 9: opinion on reducing urban speeds

Question 9 asked respondents to indicate (given their responses to the above questions) what their recommendation (from 1 ‘strongly oppose’ to 7 ‘strongly support’) would be for reducing urban speeds (to less than 50 km/h) in each of the following scenarios:

- Reduced speeds of a whole urban area (i.e., all roads within the urban limits),
- Reduced speeds in urban residential areas (i.e., all speeds within living zones only),
- Reduced speeds on urban local roads (i.e., excluding classified roads such as arterials),
- Reduced speeds in high pedestrian areas (i.e., near local shops, schools, central city),
- Reduced speeds in localised business areas (i.e., central city, suburban shopping areas).

The average rating for each option is shown in Figure 54.

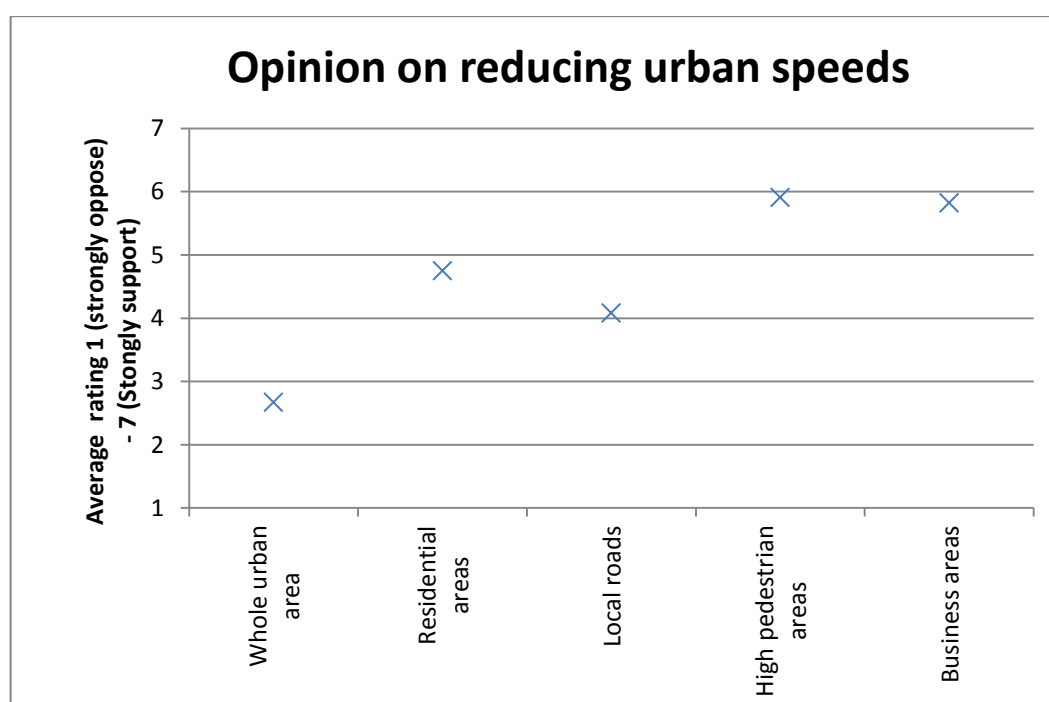


Figure 54: Opinion on application of reduced speeds in urban areas

The greatest level of support for reduced urban speeds was in high pedestrian and business areas. This may reflect the most common uses of reduced urban speeds in New Zealand. There was also a reasonable level of support for reducing speeds in residential areas. Local

roads had a relatively central (neither support nor oppose) average rating. This may reflect the understanding of what constitutes a local road and / or the variability in types of local road (culs de sac to several thousand vehicles per day). There was opposition to application of reducing speeds in whole urban areas. This may reflect the greater impact on factors such as travel time when also applied to arterial roads.

A comparison of engineers' and planners' opinions on reducing urban speeds is shown in Figure 55.

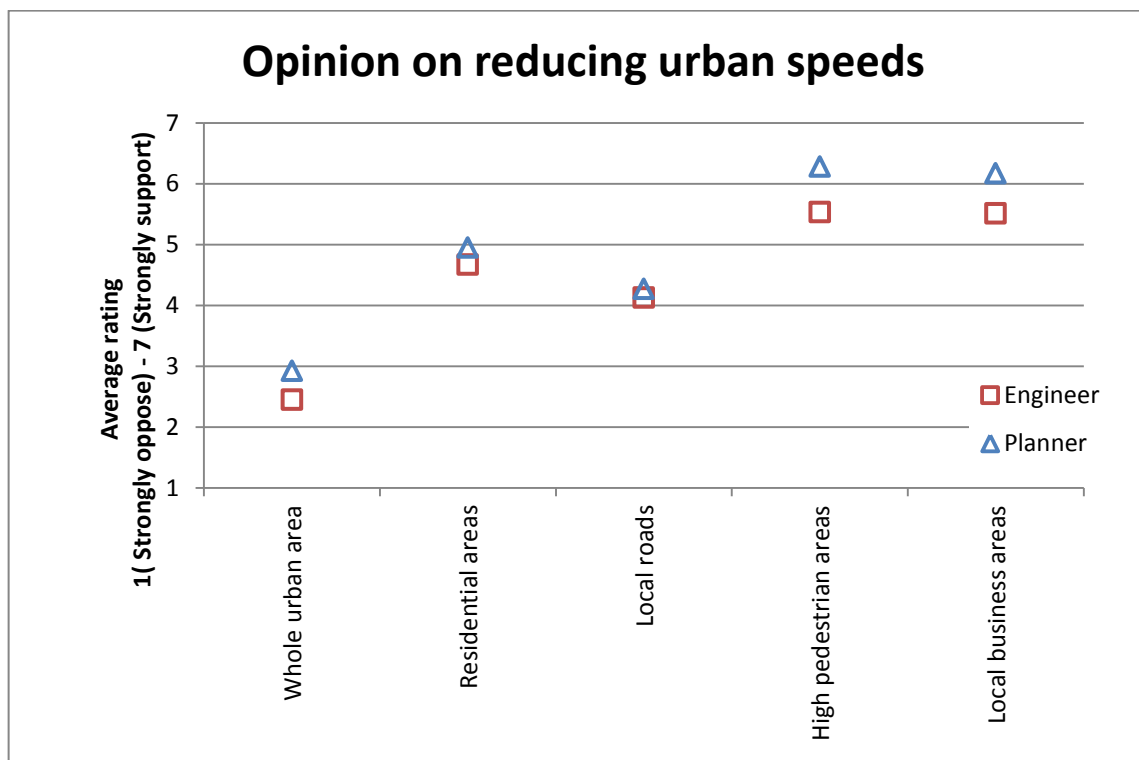


Figure 55: Opinion of engineers and planners on application of reduced speeds in urban areas

There was little difference between the average rating of planners and engineers for local roads and residential areas. The greatest difference was in respect to high pedestrian areas. The planners' average rating was more supportive than the engineers, for all five options.

Comparison of the results by years of experience is shown in Figure 56.

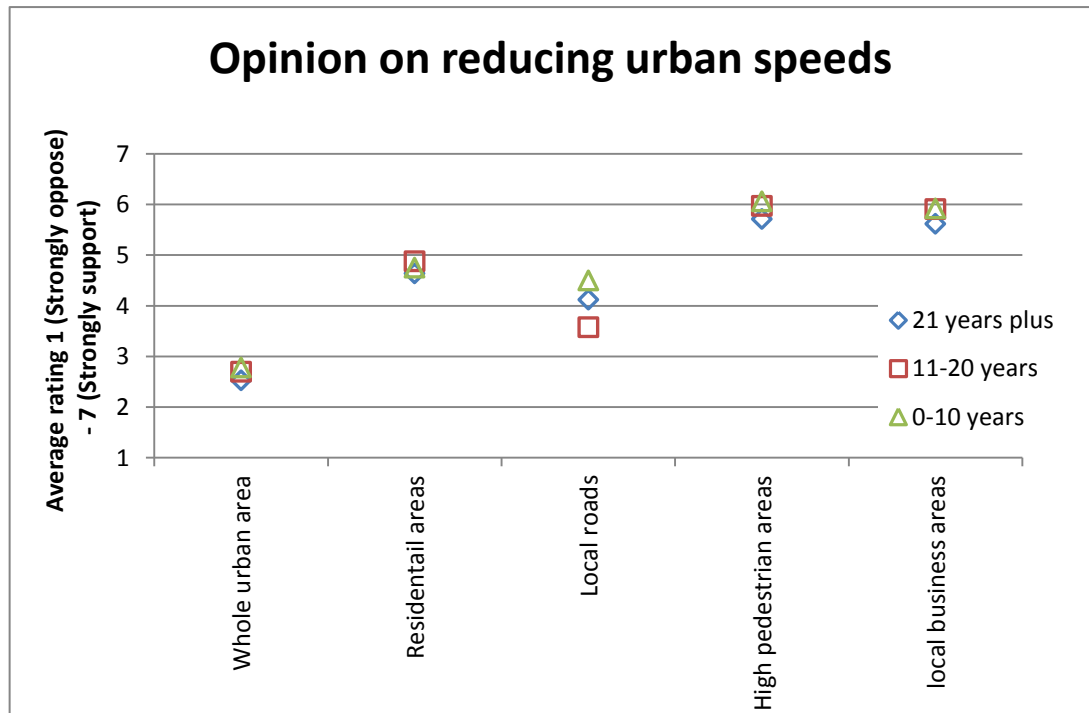


Figure 56: Opinion on reducing urban speeds in urban by years of experience

The ‘0-10 years of experience’ group provided the most supportive average rating for all options, except residential areas. The ‘21 years plus’ group provided the least supportive rating for all options except, local roads. The average ratings were however very similar except for local roads. There was a wide range of responses, for all three experience groups, with respect to local roads. Given the consistent and positive ratings for the residential areas, and business areas, it is difficult to understand why there is such a range of opinions in respect to local roads (as most urban local roads are in residential or business areas). One explanation may be the understanding of what a local road entails. Whilst the survey wording stated that a local road excluded classified roads such as arterials, it may be that some respondents considered this to mean roads controlled by the local council (i.e., all roads other than State Highways). There were no comments specifically relating to local roads which provide any insight as to the range in the responses.

Comparison of the opinions, between those with and without speed-related experience, are shown in Figure 57.

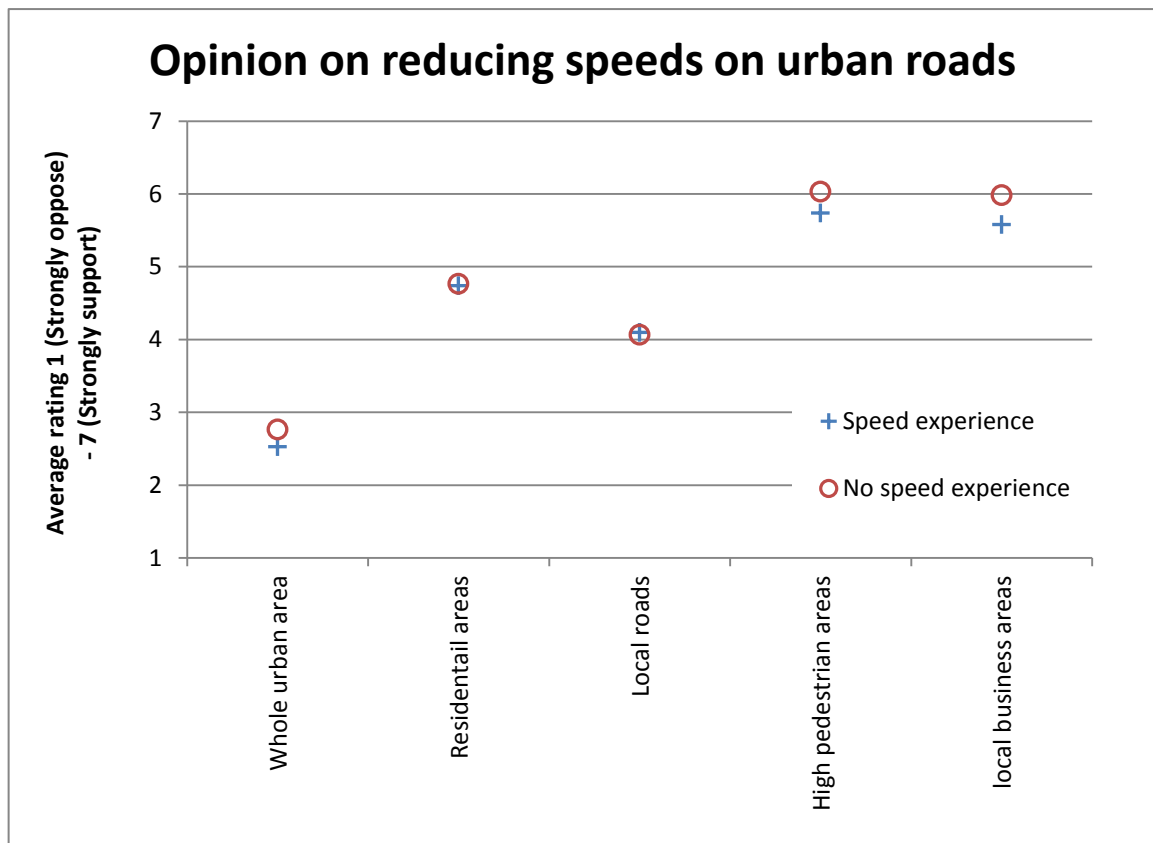


Figure 57: Opinion on application of reduced speeds in urban areas speed and no speed experience

The greatest difference in average rating between those with and without speed-related experience was for the local business areas. There was very little difference between the two groups average ratings, for residential areas and local roads. Those without speed-related experience gave a more positive (supportive) rating for all options, except local roads.

The reasonably consistent average rating for whole urban areas, between all the subgroups, was also reflected in respondents' comments. A number of the comments stated that blanket application of reduced speeds was not appropriate, particularly stating the example of arterial roads. Other comments suggested that a site-by-site analysis was needed, in order to appropriately consider all the relevant aspects, when determining whether a lower speed is appropriate. Some comments also noted a greater level of support for business areas or areas with high pedestrian volumes, on the basis of meeting the different functions of these roads.

Interestingly, several respondents suggested that the survey should also have included an option for reduced speeds at different times of the day. This reflected the view that reduced

speeds may be justified during certain times of day but cause unnecessary restriction during other times (e.g. during night time periods where pedestrian volumes are low).

Several respondents also commented on the benefits which could be achieved if there was a greater level of compliance with the existing 50 km/h urban limit. Others noted the difficulties with achieving compliance with the 50 km/h limit as a reason that reduced limits (particularly on wider scales) were not supportable in the current New Zealand climate. There was however also recognition that in some areas, congestion was already resulting in speeds less than 50 km/h.

Overall in respect to this question, it is concluded that there is general support amongst industry professionals for the provision of reduced speeds in residential, high pedestrian, and business areas. There is consistent opposition to application of reduced speeds across the whole urban area. In respect to reducing speeds on local roads, it is evident that this would require further consideration and / or debate before a clear consensus view could be determined.

There was a reasonable level of consistency within subgroup responses however generally planners and those with no speed-related experience were more supportive, and those with the least years of experience were more supportive than those with the most.

5.4 Limitations of results

There are a number of limitations of the survey results which must be acknowledged.

Firstly, respondents were self-selected (i.e., members of professional bodies who receive the survey link choose whether they wanted to respond). This may mean that results could be biased by over-representation of respondents with a particular interest or view-point. To some extent this is not entirely undesirable as the survey was aimed at identifying the opinions of professionals involved in this area of transport. Although there may be more respondents with a strong view or opinion, analysis of the results suggests that respondents had a reasonable range of views. Self-selection bias was also minimised by advertising the survey as relating to sustainable land transport rather than relating solely to reducing urban speeds. The optional prize draw also sought to encourage respondents with less interest in the topic.

There may also be a response bias in relation to the target population. In this respect the survey link was distributed only to members of the above listed professional bodies. The responses therefore do not include professionals who are not aligned with one of these professional bodies. It is not however expected that those aligned with professional bodies would have a strong difference in opinion, from those who are not.

Questions 1-3 obtained information about respondents' work experiences. Responses showed that there was a reasonable mixture of experience, across all three of these questions. Many respondents had worked in several areas (such as consulting and government sectors). This indicates a mixture of views, but does not necessarily guarantee representativeness, unless the proportions match the overall experience of the population of industry professionals (this would be difficult to determine).

Response to all questions was not compulsory (i.e., respondents could skip questions). It is difficult to interpret the impact of non-responses, for example, a non-response could signal uncertainty, complexity, or lack of interest in the question topic, or a neutral opinion. Given there was an 81% completion rate, there were ample responses to enable meaningful analysis.

In terms of survey method, an effort was made to word questions so as to avoid being leading or suggestive. In order to avoid uncertainty and identify potential wording biases, a trial survey was undertaken on staff at a Christchurch consultancy (around 15 staff with planning and engineering roles). This trial was used to determine if the proposed survey questions were understandable and to check that the online survey software was working and user friendly. Following this feedback some changes to the format and text were made. The staff used in the trial were close colleagues and were therefore asked not to respond in the final survey, to avoid biased answers.

Respondents were allowed to comment on questions 4-9, and this provided an opportunity for them to explain their answers or provide an answer outside of specified responses to each question.

The comments section also provided an opportunity for respondents to state that they may not have understood the question. A small number of comments on questions 4-7 indicated

these questions were difficult to interpret or to determine an answer. Overall however it appears that most respondents had a reasonable understanding of what was being asked.

Where it was potentially difficult to explain concisely what an option was, examples were provided. This creates a risk that the example may narrow the respondent's consideration of the topic. Conversely where it was desired to narrow consideration to specific aspects, some comments (for questions 5, 6, 8 and 9) suggested that respondents found it difficult to consider the question without knowing additional information (for example, how a method was to be achieved). This was particularly so where respondents were asked to give a response assuming that something could be achieved, even though constraints (e.g. legislation) may mean that it is not currently possible.

The survey was structured so that the order in which questions appeared in the survey was set. To avoid biasing the response to more general questions, such as the importance of speed compared to other sustainable land transport methods, the speed-related questions were last. Responses to speed-related questions suggested that respondents were thinking about aspects that came in following questions. This may have been unavoidable regardless of the order of the questions.

Overall, the survey results have some limitations, however for the purpose of obtaining information on the opinion of professionals on reducing urban speeds, the results are not considered to contain any significant biases which would render them misleading.

5.5 Conclusions from the survey

The survey indicates that respondents considered reducing urban speeds to be one of the least effective methods for achieving sustainable land transport outcomes. The answers to question 8 (whether reducing urban speeds would contribute to sustainable land transport) however show a slightly positive view of the impact of reducing urban speeds on sustainable land transport, that is not entirely consistent with the slightly ineffective rating given in question 4 (in terms of how effective these measures would be at achieving sustainable land transport objectives). The spread of responses for these two questions are similar and indicate a wide range of views and a small degree of polarisation either side of the central position.

The slightly more positive rating for question 8 may reflect a change in respondents' opinions following consideration of questions 6 and 7. Alternatively this may suggest that whilst respondents consider that reducing urban speeds would achieve sustainable land transport objectives, they consider it will not be a very effective way to achieve such objectives. Walking and cycling infrastructure, and improved public transport, are considered to be the most effective methods.

Reducing urban speeds was not considered particularly easy or difficult to implement. Advertising, education or awareness campaigns were considered the easiest method to implement and fuel or vehicle mileage taxes, the most difficult.

A comparison of the average rating for achievability (question 5) and the average rating for effectiveness (Question 4) is shown in Figure 58 . These two factors are considered to affect whether a method is considered worth adopting in terms of realising sustainable land transport outcomes.

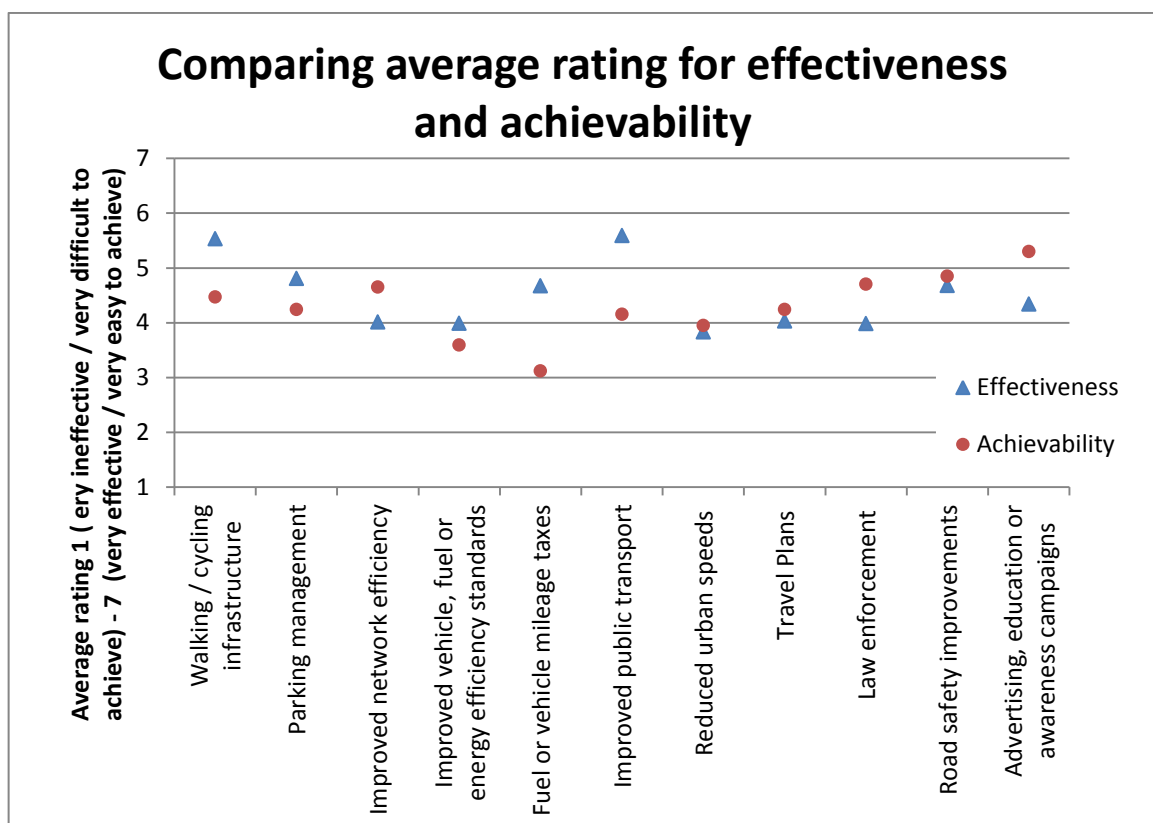


Figure 58: Comparison of average effectiveness and achievability ratings

The greatest variation in average ratings of effectiveness and achievability was fuel or vehicle mileage taxes and improved public transport. In both cases, they were considered to be more effective than achievable. There was also a notable difference between the effectiveness and achievability for advertising, education and awareness campaigns and walking / cycling infrastructure. Walking / cycling infrastructure was also considered to be more effective than achievable, however the reverse was observed for advertising, education and awareness campaigns. The greatest consistency, in terms of the average effectiveness and achievability ratings, related to the reduced urban speed, travel plans, and road safety improvement methods.

In respect to question 7, the factors considered most likely to facilitate achieving reduced urban speeds were residents' opinion, and industry expertise and knowledge. Political opinion, public opinion, and cost / budgets were considered to be the most likely to restrict reducing urban speeds.

In terms of the effects of reducing urban speeds, amenity and safety were anticipated to have the most positive change and travel times the greatest adverse effect. There was a reasonable range of views on the effects on vibration and noise, use of motor vehicles, fuel usage and vehicle emissions.

There was overall support for reducing urban speeds in high pedestrian and business areas and some support for reducing speeds in residential areas. There was general opposition to application of reduced speeds to whole urban areas, and a range of views on whether or not it should be applied to all local roads.

6 Discussion

This research considers both the potential efficiency and effectiveness of reducing urban speeds as a method to contribute to achieving sustainable land transport outcomes. This approach recognises that both these aspects are likely impact on whether different methods to achieve more sustainable land transport outcomes are adopted in New Zealand. In this respect, the average effectiveness and efficiency ratings from the survey results can be compared to the proportional use of each method in the Hamilton and Wellington council strategies (refer to section 2.3.2).

Survey question 4 asked industry professionals to rate how effective they thought a variety of methods would be. The average ratings can therefore be compared to the percentage of use of these same types of methods identified in Wellington and Hamilton strategies (refer to Figure 2). This is shown in Figure 59.

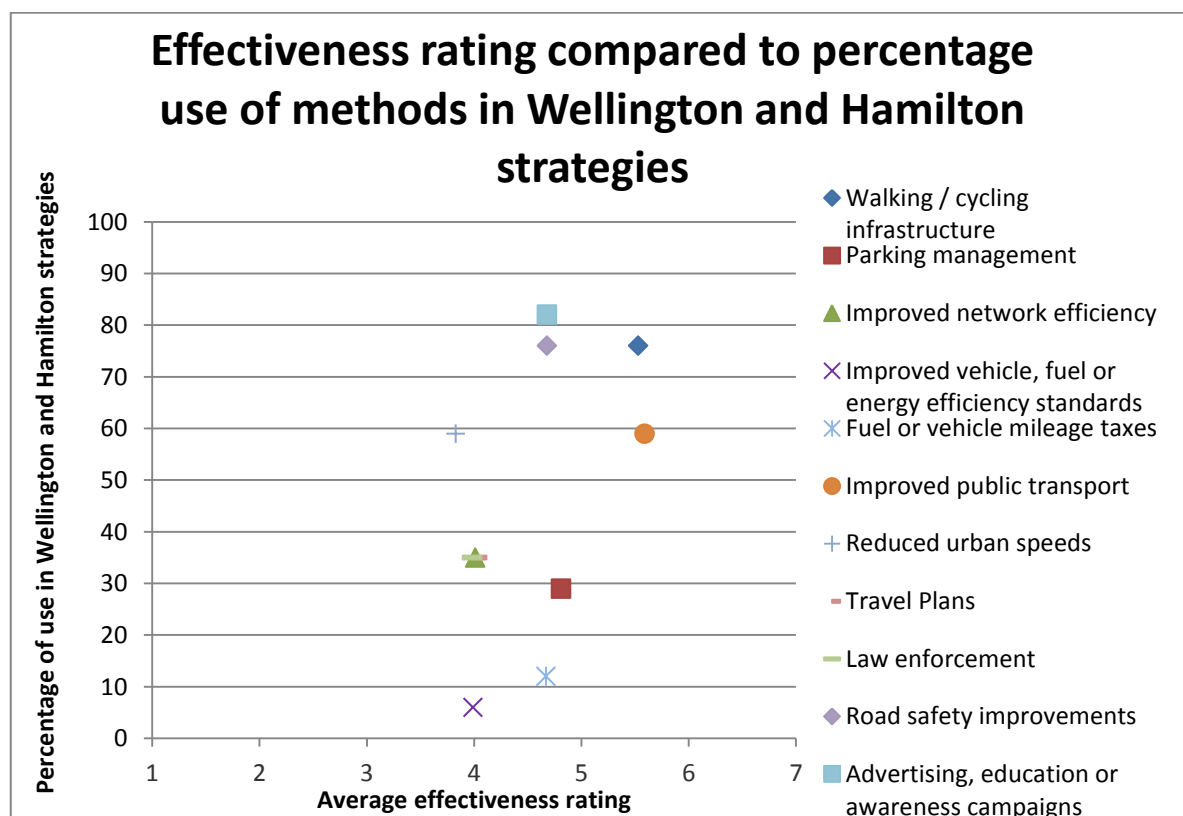


Figure 59: Effectiveness rating compared to percentage use of methods in Wellington and Hamilton strategies

The comparison of the perceived effectiveness, and rate of use of methods in Wellington and Hamilton strategies, does not show a clear relationship. A similar comparison is undertaken below in terms of the average efficiency rating for each method (survey question 5).

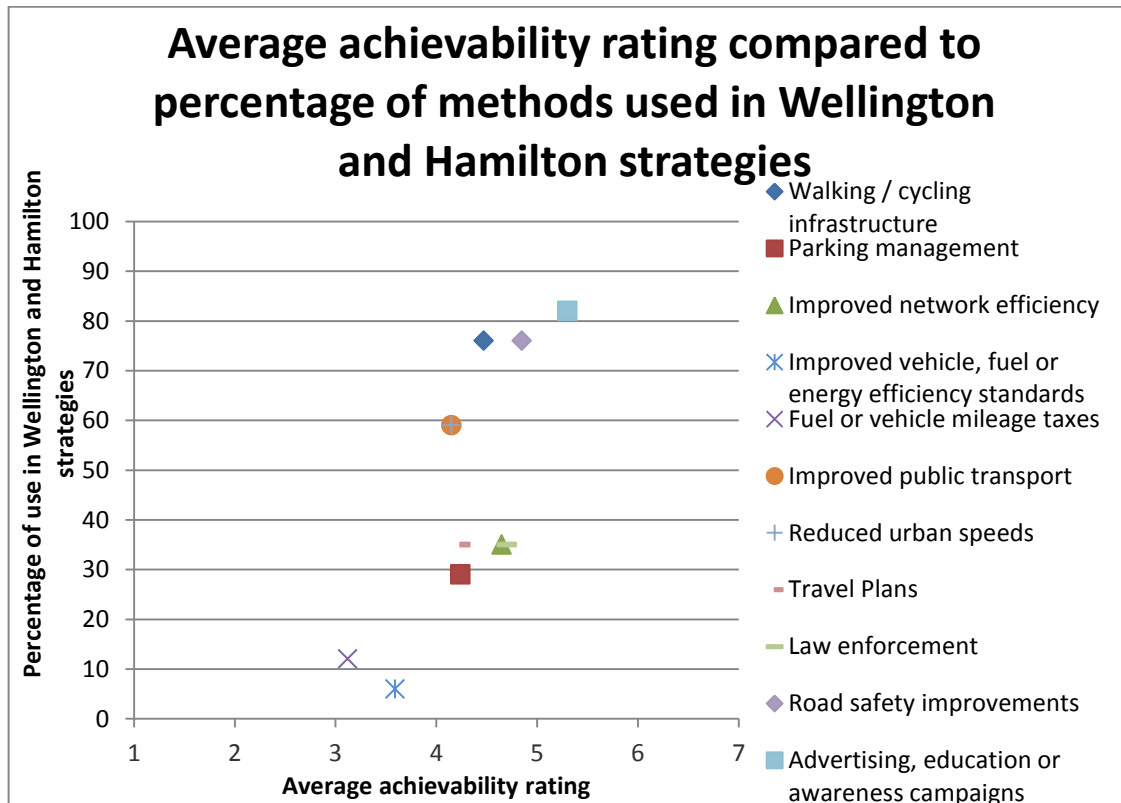


Figure 60: Achievability rating compared to percentage use of methods in Wellington and Hamilton strategies

There appears to be a weak relationship between perceived efficiency and use of the methods within Wellington and Hamilton Strategies.

Averaging the effectiveness and achievability ratings and comparing this average to the percentage of methods used, gives a stronger relationship as shown in Figure 61.

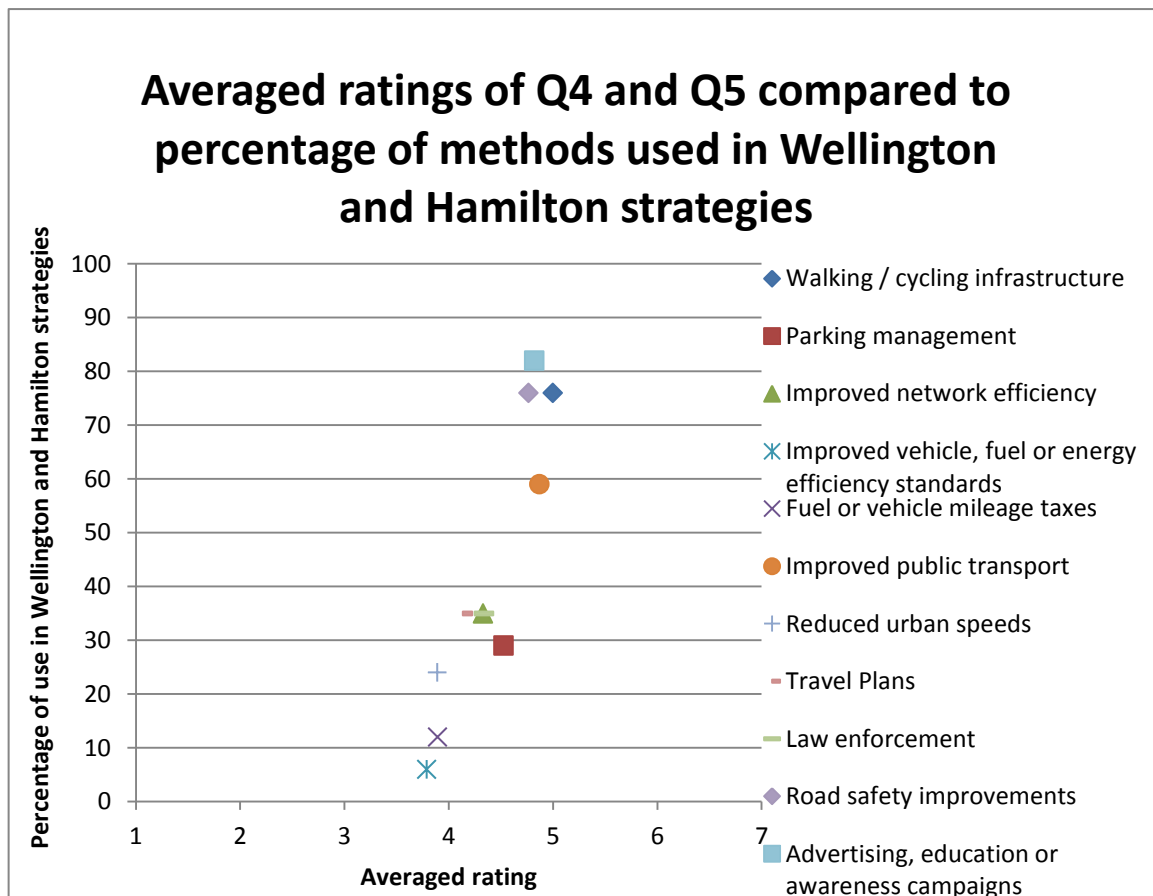


Figure 61: Combined effectiveness and efficiency rating compared to percentage use of methods in Wellington and Hamilton strategies

This supports the theory that it is a combination of effectiveness and efficiency of methods that is central to understanding why they may or may not be adopted in New Zealand. This recognises that, for example, a method could be highly effective, but very difficult to implement, such that other less effective methods are adopted because they are relatively easy to implement. That said, the difference between the most and least commonly adopted methods was only 1.2 averaging rating points.

The following discussion compares the findings of the literature review, case studies and survey responses, in terms of the likely effectiveness and efficiency of lower urban speeds, to achieve sustainable land transport outcomes in New Zealand.

6.1 Efficiency

In terms of the likely efficiency, consideration has been given to factors known to affect implementation of sustainable land transport methods in New Zealand including: time and

cost, legislation, public and political opinions. The survey, case study and literature review findings are summarised below in respect to each of these factors.

6.1.1 Likely success of implementation

The key conclusions from the literature review, case studies and survey, in respect to the likelihood of successfully implementing reduced urban speeds in New Zealand are bullet pointed below.

Literature review:

- Physical measures, visual cues and legal measures (used in accordance with best practice) will achieve reduced speeds.
- Speed limits alone achieve the least reduction. The greatest reductions are typically associated with combined approaches.

Case studies:

- Both Unley and Graz achieved reductions in speed although the full extent of the reductions has not been sustained in Graz. Speeds have continued to decrease in Unley.
- Most sites surveyed in Hamilton have had a reduction in speed (a couple had no change).

Survey:

- The ability to monitor changes was considered to slightly restrict achieving reduced urban speeds.
- Reducing urban speeds was considered to be neither easy nor difficult to implement (neutral response).
- The majority of respondents indicated they would recommend reducing urban speeds in residential areas, high pedestrian areas, and business areas, in New Zealand.

It appears that there is ample information available to show that reduced speeds can be successfully achieved using legal, physical, and / or visual cues. Although there is little

information on post-implementation speeds, limited research by Charlton and Baas (2006) shows that New Zealand drivers responses to physical devices and visual cues is similar to that observed internationally. The survey responses indicated that the ability to monitor changes may, however, slightly restrict urban speed reductions. This may be because it can be difficult to conclusively measure improvements, such as crash reductions. The Hamilton case study shows that councils can successfully implement lower urban speed limits in New Zealand using limited visual and physical measures.

6.1.2 Time and Cost

The key conclusions from the literature review, case studies and survey, in respect to the time and cost of reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- The cost varies depending on the method adopted, generally physical methods and visual cues have a greater upfront cost, but require less enforcement. Speed limit changes in isolation may generate greater ongoing enforcement costs.
- Physical works may take additional time to implement and enforcement may require considerable police time.

Case studies:

- In Graz, time and cost constraints led to use of speed limits and enforcement methods rather than associated physical methods. The implementation costs were around \$716,000 (NZD) and there are annual costs of around \$204,600 (NZD), however, it is not clear if this annual cost covers the cost of enforcement.
- In Graz and Unley final adoption of lower speed limits took longer due to the need for trial periods.
- In Hamilton the cost of approved / implemented changes is around \$931,000-967,000 (55% of which has been subsidised by central government) with potential for approximately an additional \$1,597,000 to complete 41 more, 40 km/h areas, by 2015.

Survey:

- Both cost and time were considered to constrain the ability to implement reduced urban speeds in New Zealand.

The cost and time to implement speed reductions vary significantly, depending on the methods used, and whether trials are needed. The Hamilton case study shows that with central government funding assistance (55% subsidy) the cost of reducing the speed limit from 50 km/h to 40 km/h, in residential areas, is achievable. Speed reductions in other cities, for example, Wellington, show that the cost of reducing speed limits, in some business areas is also achievable, without specific central government funding. Although overall uptake of reduced urban speeds in New Zealand has been relatively slow, the time to implement does not appear to be significant. Hamilton City Council is planning to implement 41 additional 40 km/h areas over 3 years.

6.1.3 Legislation

The key conclusions from the literature review, case studies and survey, in respect to legislative requirements of reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- New Zealand legislation allows lower urban speed limits but potentially some improvements or guidance could encourage wider uptake.

Case studies:

- Graz legislation changes allowed City staff to be contracted to police to increase enforcement resources.
- Unley local government has responsibility for setting speed limits.
- Hamilton has successfully adopted 40 km/h speed limit areas.

Survey:

- Current legislation is considered to only slightly constrain implementation.
- The ability to enforce speed reductions is considered to slightly restrict achieving reduced speeds.

The current New Zealand speed limit setting legislation enables councils to adopt lower urban speeds. Survey responses however indicated that respondents considered legislative requirements may slightly restrict the ability to achieve reduced speeds. The survey comments suggest that this may reflect a view that the process is time consuming and cumbersome. One respondent particularly noted the need to undertake public consultation and change bylaws. It is likely that some additional guidance on applying the current legislation, to speed limits below 50 km/h, would be useful.

Despite New Zealand police enforcement efforts for existing speed limits respondents considered that enforceability would restrict achievement of reduced urban speeds. It is assumed this reflects a lack or perceived lack of police resources.

6.1.4 Industry knowledge

The key conclusions from the literature review, case studies and survey, in respect to industry knowledge, on reducing urban speeds in New Zealand, are bullet pointed below.

Literature review:

- There is a reasonable and growing volume of literature internationally but limited guidance available in a small number of New Zealand documents.
- New Zealand urban speed reduction experience is primarily associated with local area traffic management / traffic calming.

Case studies:

- A lack of similar examples lead to use of trials prior to wider application of speed limit reductions in both Unley and Graz.
- Implementation in Hamilton has been on an area by area basis. They have however undertaken some research into marketing and development of appropriate signage / road markings for use in their Safer Speed Areas.

Survey:

- Industry knowledge was considered to slightly facilitate implementation.

In terms of industry knowledge, there are a growing number of international and New Zealand case studies. Internationally there are also an increasing number of research reports and government guidance documents available on reducing speed limits. There appears to be a need for more New Zealand guidance and research, to assist professionals with the process for lowering urban speed limits. This is considered particularly important given that the survey results suggest that New Zealand professionals may be over-estimating the dis-benefits of reducing urban speeds on travel times, vehicle emissions, and fuel usage.

The survey findings suggested that industry knowledge would slightly facilitate reducing urban speeds but overall it appears that a lack of industry knowledge in New Zealand is probably contributing to the slow uptake of reduced urban speeds.

6.1.5 Public opinion

The key conclusions from the literature review, case studies and survey, in respect to public opinion on reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- New Zealand appears to be consistent with many international examples where there is increasing support for reduced speeds in residential areas.
- There is nothing to suggest that the general public would not support reducing urban speeds.

Case studies:

- The majority of the public supported speed changes in both Unley and Graz (although in Graz this was temporarily below 50% immediately prior to implementation).
- Ongoing levels of support have continued to increase in Graz but are declining in Unley (possibly due to changes in the national default urban speed limit).
- In Hamilton approximately equal numbers of residents agreed and disagreed that 40 km/h speed limits should be applied to all residential areas in Hamilton.

Survey:

- General public opinion was considered to restrict implementation but residents' opinion was considered to support implementation.

Internationally there appears to be a growing level of public support for lower urban speeds. In both Unley and Graz there is majority support for the reduced speed limits. In the limited public opinion surveys available in New Zealand there appears to be support from residents for reducing urban speeds in residential areas.

The survey responses indicated residents' opinion would be expected to only slightly facilitate reducing urban speeds and that overall public opinion would restrict this. There is a lack of information available regarding overall public opinion on reducing urban speeds. There is however nothing to suggest that there was any opposition to reducing urban speeds. In respect to the residents' opinion, the examples reviewed suggest that residents' opinion is likely to support reducing urban speeds.

6.1.6 Political opinion

The key conclusions from the literature review, case studies and survey, in respect to the effects of political opinion on reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- There does not appear to be strong political drive (like that in the United Kingdom) to reduce urban speeds in New Zealand but there is nothing to suggest that local or central government are unwilling to support reducing urban speeds.
- Political support varies at local government level between territorial authorities.

Case studies:

- Strong political support in Graz and political support in Unley, appear to have been critical to achieving the lower speed limits.
- Hamilton showed strong political support at local council level to gain funding support from central government.

Survey:

- Political opinion was considered to restrict implementation of lower urban speeds in New Zealand.

Political support appears to be an important aspect in implementing lower urban speeds. Unlike the United Kingdom, there does not appear to be strong political drive from central government to reduce urban speeds in New Zealand. Political support appears to vary widely at local government level with greater support in Wellington and Hamilton reflected in the greater number of lower speed limits. The survey responses therefore appear to underestimate the likelihood of political support. The awareness of some of the benefits particularly related to safety may contribute to greater political support for reducing urban speeds. Regular mention at TRAFINZ¹⁶ conferences, in their publications and submissions could also assist.

6.1.7 Summary of efficiency

It is concluded that lower urban speeds can be successfully implemented in New Zealand. Whilst the survey results indicate that time and cost, restrict the ability to achieve reduced urban speeds, the Hamilton and Wellington examples show that time and cost requirements are achievable in New Zealand. Legislation permits lower urban speeds to be implemented, however, guidance could be provided to facilitate greater uptake of lower urban speed limits. There is a general lack of experience and research on reducing urban speeds in New Zealand, which is contributing to a lack of industry knowledge, particularly regarding perceived dis-benefits of reducing urban speeds. Public and political opinion are difficult to determine, however, there is often support from residents. Political support for reducing urban speeds varies by local government and appears to be important in the uptake of lower speed limits. Industry professionals may be under estimating the level of political and public support.

Overall in terms of efficiency, the key limitations in New Zealand appear to be associated with the existing legislative process and a lack of industry knowledge. Local government and residents' opinions appear to be key factors in facilitating reduced urban speeds.

¹⁶ TRAFINZ is the New Zealand Local Authority Institution and represents local authority views on road safety and traffic management in New Zealand. It exists to lobby the government to influence decision making road safety on and traffic issues.

6.2 Effectiveness

The effectiveness of reducing urban speeds to achieve sustainable land transport outcomes has been considered in respect to seven building blocks of sustainable land transport. These building blocks are: safety, accessibility, environmental sustainability, public health, functional transport networks, economic development, and integrated urban form. The findings of the literature review, case studies and survey are discussed below, in respect to each of these building blocks.

6.2.1 Safety

The key conclusions from the literature review, case studies and survey, in respect to the safety effects of reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- Causal relationship between reduced speeds and reduced crash rates, particularly for fatal, serious and pedestrian / cyclist crash types.

Case studies:

- Both Unley and Graz results suggest a reduction in crashes, particularly serious crashes and crashes involving pedestrians and cyclists.
- Survey results suggested residents in Hamiltons 'Safer Speed Areas' felt safer and were more willing to walk or cycle.

Survey:

- Respondents considered that reducing urban speeds would improve all three crash outcomes. They considered it would improve crash severity by the most followed by the number of pedestrian and cycle crashes.

There is a high level of consistency in respect to the findings on safety. It is concluded that reducing urban speeds would lead to the number of crashes reducing. Crash severity and the number of crashes involving pedestrians and cyclists would also be expected to decrease. It is concluded that reducing urban speeds would contribute to achieving sustainable land transport safety-related outcomes.

6.2.2 *Accessibility*

The key conclusions from the literature review, case studies and survey, in respect to the effects on accessibility from reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- Reducing urban speeds improves accessibility for pedestrians and cyclists both in terms of negotiating traffic and through increased security (reduction of crime).

Case studies:

- In Graz the reduced urban speeds were introduced as part of a focus on total mobility however the effects on this were not analysed.
- In Hamilton 29% of residents surveyed indicated that they were more willing to walk or cycle after implementation of the 40 km/h speed limits.

Survey:

- Incidents of crime were expected to slightly decrease if there was any effect at all.
- Travel choices were expected to slightly improve if there was any effect at all.

The findings of the literature review are consistent with the survey responses, in that reducing speeds is likely to increase accessibility for walking and cycling (for existing users, even if no mode shift is achieved). Increased surveillance from drivers may also reduce the fear of crime. The survey results indicated that a slight increase in travel choices was anticipated and this is consistent with the Hamilton survey findings (that some people were more willing to walk or cycle). Overall, reducing urban speeds is likely to contribute to accessibility.

6.2.3 *Environmental sustainability*

The key conclusions from the literature review, case studies and survey, in respect to the effects on environmental sustainability related outcomes from reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- Overall it was concluded that there would be no noticeable change in vehicle emissions or fuel use although there may be very small localised reductions in some emissions such as particulate matter and nitrogen dioxide.
- Reducing urban speeds could encourage mode-shift however there is insufficient evidence at this stage.

Case studies:

- In Graz there was no significant change in vehicle emissions overall but a noticeable reduction in nitrogen oxide emissions in 30 km/h streets.
- In Graz surveys indicated no mode-shift and very little change in route choice.
- Studies in Graz found no change in fuel usage.
- Traffic volumes decreased on some streets in Unley and on monitored streets in Hamilton and it is assumed this represents changes in route choice.

Survey:

- Reducing speeds was expected to slightly worsen vehicle emissions and increase fuel usage if it had any affect at all.
- Reducing urban speeds was expected to slightly decrease the number of people choosing to drive and perhaps slightly decrease the amount of motor vehicle travel.

In terms of environmental sustainability the survey responses indicate that vehicle emissions and fuel usage were expected to slightly increase (if there is any effect at all) and that the number of people choosing to drive and the amount of motor vehicle travel may decrease slightly (if there is any effect at all). Vehicle emissions and fuel usage were considered only in the Graz case study. This suggests that there would be no noticeable change in either vehicle emissions or fuel use, which is consistent with the findings of the literature review.

The literature review was inconclusive in terms of mode shift; it is likely that reducing urban speeds may contribute to mode shift but there is insufficient evidence to determine whether this is the case.

The average survey responses were reasonably consistent with the findings of the literature review and case studies. That said, the spread of responses in respect to vehicle emissions and fuel usage (in Appendix 6) suggests a wide range of views within the industry, with only 30% of respondents selecting the neutral / no change option.

It is likely that reducing urban speeds would contribute to environmental sustainability given the likely contribution towards mode-shift however the contribution would be less certain than the effects on safety.

6.2.4 Public health

The key conclusions from the literature review, case studies and survey, in respect to the effects on public health from reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- Reducing speed reduces noise.
- There would likely be health benefits from increased physical activity if this occurs either from mode-shift or increased physical recreation / play.
- There may be some health benefits from even very small localised reductions in certain types of emissions (nitrogen oxides and particulate matter).
- A reduction in crash numbers and severity would directly result in public health benefits (reduced loss of life and / or injuries).

Case studies:

- Monitoring in Graz indicated that noise pollution decreased slightly.
- In Graz nitrogen oxide levels decreased on 30km/h streets.

Survey:

- Reducing speed was expected to slightly improve (i.e., decrease the level of) vibrations and noise.

- In terms of secondary effects, safety was considered to improve which would contribute to social cost savings. Vehicle emissions and crime were considered to slightly worsen and improve respectively.

The survey responses related to public health were consistent with the findings of the literature review and case studies, in terms of decreasing noise and the secondary effects of improved safety. In terms of secondary effects from vehicle emissions, it is noted that emissions of nitrogen oxides and particulate matter are considered to be particularly harmful to human health. These two emissions are likely to decrease slightly as a result of reducing urban speeds. The extent to which people are actually exposed to these emissions is however difficult to determine (for example, highest concentrations occur along busy arterial road sides).

The literature review also identified some health benefits from increased physical exercise. These would eventuate only if the reduced speeds encourage mode shift or make the street more liveable, encouraging increased play / active recreation.

Overall there was reasonable consistency between the findings of the survey, case studies and literature review and it is concluded that public health would be likely to improve as a result of reduced urban speeds.

6.2.5 Functional transport networks

The key conclusions from the literature review, case studies and survey, in respect to the effects on functional transport network related outcomes from reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- Travel times slightly increase but not proportional to change in speed.
- Lower speeds can create smoother traffic flows / reduce congestion.

Case studies:

- In Graz congestion on arterial roads (where speed limit not reduced) anticipated by residents did not eventuate.

- In Unley modeling suggested that lower speeds increase travel time by a small amount (on average less than 60 seconds). The modeling also found that delay does not always increase with reduced speed limits.
- In Hamilton residents survey results indicated that the majority of people do not consider the 40 km/h area to be an inconvenience.

Survey:

- Reducing speeds was anticipated to increase travel times.

In terms of functional transport networks, the survey responses accurately identified that travel times would increase. The average rating (for survey question 6) however suggested that the effect of the increased travel time was likely to be of a similar magnitude (but opposite effect) to the improvement in the number of motor vehicle crashes. From the findings of the case studies and literature review, the number of crashes is likely to substantially decrease, proportionately to the reduction in speed. Travel times are only likely to increase to a small degree and not proportionately to the reduction in speed. It is therefore possible that industry professionals may be over-estimating the impact of reducing urban speeds on travel times.

There may also be benefits from reducing urban speeds on functional transport networks, for example, reduced congestion. It is however concluded that reducing urban speeds would not contribute towards achieving functional transport outcomes, due to the dis-benefits associated with increased travel times, however these dis-benefits are considered to be small, particularly in comparison to some of the benefits in respect to the other sustainable land transport outcomes.

6.2.6 *Economic development*

The key conclusions from the literature review, case studies and survey, in respect to the effect on economic development from reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- There is unlikely to be a noticeable change in fuel use or vehicle operating costs.

- Potentially a slight increase in travel costs due to increased travel times.
- Likely to be noticeable social cost savings from reduction in crashes.
- Potentially an increase local foot traffic improving sales for local businesses.
- Overall comparisons suggest that total benefits outweigh the total costs.

Case studies:

- In Graz there was no change in fuel usage.
- In Graz and Unley there was a decreased crash rate but information on the resultant economic impacts.

Survey:

- Fuel usage and travel time expected to slightly worsen.
- Crash rates anticipated to decrease.

In terms of economic development, the relevant survey responses related to secondary effects of travel times, fuel usage and safety. The survey responses may have slightly overestimated the adverse effects on travel times and fuel usage. The literature review also indicated that the increase in travel times is not likely to have a significant effect on the cost of transport (and therefore cost of goods) and may be off-set by some localised benefits for businesses (from increased foot traffic). Accident savings could also have a noticeable social cost saving and total benefits are likely outweigh total costs. On balance therefore reducing urban speeds is considered contribute to economic development.

6.2.7 Integrated urban form

The key conclusions from the literature review, case studies and survey, in respect to the effects on integrated urban form from reducing urban speeds in New Zealand are bullet pointed below.

Literature review:

- Reducing speeds improves the liveability of residential streets.

- There may be less space required for roads in new subdivisions and there is potential for some space in existing road corridors to be re-used for plantings / other purposes.

Case studies:

- In Graz amenity may improve due to slight reductions in noise pollution.
- Studies undertaken in Unley concluded that amenity had improved.

Survey:

- Amenity, noise pollution and amount of vibrations were all anticipated to improve.

The relevant survey responses, with respect to integrated urban form, relate to benefits from anticipated improvements in amenity, vibration and noise which may contribute to improving the liveability of an area. This is consistent with the case study findings in Unley, where improvements in amenity were identified, and in Graz, where slight improvements in noise pollution were identified.

The literature review identified that reduced urban speeds are likely to improve the liveability of residential areas and may also make more efficient use of space. Overall reducing urban speeds is likely to contribute to more integrated urban form.

6.2.8 *Summary of effectiveness*

It is concluded that reducing urban speeds is considered to contribute to sustainable land transport by improving safety, will likely contribute in terms of public health, accessibility, integrated urban form, environmental sustainability and economic development. The small dis-benefits in terms of functional transport networks are not likely to be significant in the context of the benefits from the other building blocks.

Overall there is reasonable consistency between the survey opinions, case studies and literature review findings. The key areas of difference relate to survey responses overestimating the effect on travel times compared to that suggested from the findings of the case study and literature review. Respondents also considered that vehicle emissions and fuel usage would increase, however the most recent literature and the case study findings suggest this is not the case. It is therefore considered that as a whole, industry professionals in New

Zealand are over-estimating the dis-benefits of reducing urban speeds and therefore underestimating the potential contribution to sustainable land transport outcomes.

6.3 Summary of conclusions: efficiency and effectiveness

The literature review, case studies and industry professionals survey findings allow a number of conclusions to be drawn in respect to the efficiency and effectiveness of reducing urban speeds in New Zealand.

In terms of efficiency there was reasonable consistency between the survey opinions, case studies and literature review findings. The key areas of difference related to the survey responses potentially underestimating political and public support for reducing speeds and overestimating the current contribution of industry knowledge.

Overall in respect to efficiency it is concluded that reducing urban speeds can be successfully implemented in New Zealand, time and cost requirements are achievable, legislation is permissive however additional guidance and industry knowledge is required. Political and public opinion is likely to vary by location but there is nothing to suggest that public or political opinions do not support reducing urban speeds.

There was reasonable consistency between the survey opinions, case studies and literature review findings. The key areas of difference related to survey responses overestimating the adverse effect on travel times, vehicle emissions and fuel usage. It is therefore considered that industry professionals in New Zealand may be over estimating the dis-benefits of reducing urban speeds and therefore underestimating the potential contribution to sustainable land transport outcomes.

Overall it is concluded that reducing urban speeds can contribute to achieving sustainable land transport outcomes in terms of safety, will likely contribute to public health, accessibility, integrated urban form, environmental sustainability and economic development. The impact of increased travel times on functional transport networks is likely to result in some dis-benefits however these are not likely to be significant in the context of other benefits.

The above discussions consider whether reducing urban speeds would contribute to sustainable land transport and what aspects are likely to influence how efficient it is to

implement. The following section seeks to put these findings in context by comparing them to the potential effectiveness and efficiency of providing walking and cycling infrastructure.

7 Comparative Analysis

This section seeks to compare the effectiveness and efficiency of reducing urban speeds with that of providing walking and cycling infrastructure. These two methods are compared in terms of the potential for each method to achieve sustainable land transport outcomes in New Zealand.

7.1 Reasons for comparative analysis

As outlined in section 2.3.2, walking and cycling infrastructure is one of the most commonly adopted methods in council strategies. Walking and cycling infrastructure was considered to be one of the most effective and efficient methods in the industry professionals survey (refer to section 5.3).

This section reviews New Zealand research and case studies of walking and cycling infrastructure, in terms of effectiveness and efficiency. This enables the effectiveness and efficiency, of walking and cycling infrastructure, to be compared to that of reducing urban speeds.

7.2 Comparison of efficiency

As with the above sections, consideration of the likely efficiency includes consideration of: the likely success of methods, the time and cost of implementation, legislation, public and political opinions, as well as industry knowledge.

7.2.1 Likely success of implementation

For the purpose of this report walking and cycling infrastructure will be loosely defined as any physical measure, to cater for pedestrians and / or cyclists, generally within the road corridor. Other facilities such as bicycle parking at destinations have not been considered. A variety of infrastructure is used in New Zealand including pedestrian over and underpasses, signal crossings, zebra crossings, cycle lanes and paths, and advanced stop boxes. It is not proposed to outline these measures individually (refer to Austroads, 2009 and Taylor, 2009). For the purposes of this assessment it is assumed that the most appropriate measure for the particular circumstance will be adopted. The focus is on the potential effects of providing infrastructure for pedestrians and cyclists.

In general when providing walking and cycling infrastructure the key aspects that should be considered include: connectedness (meeting desire lines), directness, coherence, legibility, comfort, convenience, pleasantness / attractiveness, safety, security, universal (cater for wide range of abilities and impairments) and accessible (New Zealand Transport Agency, 2009; Land Transport Safety Authority, 2004).

Where infrastructure does not provide for pedestrian and cyclists needs, it tends to be poorly utilised. For example, off road cycle paths that lack directness are often not used by confident cyclists who prefer to take a more direct (usually on road) route. Consultation with future users or key interest groups can assist with ensuring investment in walking and cycling infrastructure can best meet the needs of future users (Land Transport Safety Authority, 2004).

One of the most extensive New Zealand examples of a specific commitment to provision of infrastructure for walking and cycling is the Model Communities project. The New Zealand Transport Agency is providing funding for two cities (Hastings and New Plymouth) to develop infrastructure for walking and cycling, and to act as examples for increasing walking and cycling within New Zealand. The projects started during 2010 and there are already some results available particularly for Hastings (branded Iway).

There are a number of more specific examples of successful implementation of walking and cycling infrastructure (such as cycle lanes and shared paths), and these are discussed as relevant below.

Overall, there are significantly more New Zealand walking and cycling infrastructure examples to draw from than there are examples of reducing urban speeds. It is however considered that both methods can be successfully implemented in New Zealand.

7.2.2 Time and Costs

The Hastings Model Community project consists of infrastructure changes as well as associated education and awareness campaigns. The New Zealand Transport Agency is providing funding of \$3.51 million for Hastings over the 2010/11 and 2011/12 financial years (Chapman et al., 2012). In addition to the New Zealand Transport Agency funding, a further \$2.4 million of work has also been undertaken by Hastings District Council over the 2011/2012 financial year (Hastings District Council, 2012).

In terms of timeframes, the initiative started in early 2010, with the New Zealand Transport Agency calling for tenders to establish model communities. Funding started in July 2010. Hastings District Council (2011a) states that 25 km of cycle lanes have been provided and 2.1 km of off-road paths had been completed, as well as concept plans for two new walking and cycling links (with Havelock North and Clive). The Council has also undertaken a footpath renewal programme, significantly improving 23 km of paths around the district (Hastings District Council, 2011a).

The Hastings District Council sets out its funding allocation for the coming years in its Long Term Plan 2012-22 (Hastings District Council, 2012) including, committed Iway projects, and new walking and cycling projects. The proposed funding for these projects is shown in Table 11.

Table 11: Expenditure ('000 \$NZ) (Hastings District Council, 2012)

Project	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Committed Iway projects	501	115	119	154	166	138	21	14	15	15
New walking and cycling projects	158	970	54	1,285	1,145			437		103
Total	659	1,085	173	1,439	1,311	138	21	451	15	118

It is difficult to compare the costs associated with reducing urban speeds to that of the provision of walking and cycling infrastructure. A key issue is the variance in costs for different types of infrastructure used for each of these methods. The cost of narrowing carriageways is substantially different to installing speed limit signs. The cost of a shared path is also substantially different when compared to an advanced stop box.

It is possible to compare the budgets allocated in the long term plans of the Hastings model communities programme with the Hamilton safer speeds programme. The 2012-2015 budget for Hastings model communities project is \$1,917,000 and for 2015-2022 is \$3,493,000.

The 2012-2015 budget for the Hamilton safer speed areas is \$967,000¹⁷ and for 2015-2022 is \$2,756,000 (Consedine & Allen, 2012). This shows similar although slightly higher budgets for the walking and cycling projects in Hastings. It is however difficult to determine whether these two projects are of comparable scale. For example, in Hamilton they are taking an area by area approach however in Hastings they are taking more of a corridor approach.

Overall, the only conclusion that can be drawn is that there is nothing to suggest that implementing reduced urban speeds is unreasonably expensive or time consuming, when compared to provision of walking and cycling infrastructure.

7.2.3 Legislation

The “Land Transport (Road User) Rule 2004” (Ministry of Transport, 2004) sets out a number of legal requirements in respect to the use of pedestrian and cycle infrastructure in New Zealand. Some key aspects include (Ministry of Transport, 2004):

- Pedestrians must not step onto a pedestrian crossing unless approaching vehicles are far enough away to stop safely.
- A vehicle must not block a pedestrian crossing.
- In a shared zone, vehicles (including cyclists) must give way to pedestrians.
- Cycle lanes are legally identified as special vehicle lanes for exclusive use of cyclists (or buses and cyclists, when a bus lane).
- Cars cannot stop or park in cycle lanes.

Pedestrian and cyclist infrastructure is typically provided by road controlling authorities (including councils and the New Zealand Transport Agency). These authorities also have the power to enact bylaws for areas within their responsibility. Bylaws can cover activities on footpaths beside roads and on off-road paths, as well as specifying cycle lanes (special vehicle lanes). They can also be used for activities on the road that may affect pedestrians’ or cyclists’ safety or mobility (New Zealand Transport Agency, 2009).

¹⁷ Although other estimates suggest around \$1,596,672 for the works proposed over the 2012-2015 period (Consedine & Allen, 2012).

As with changes to speed limits, local councils implementing walking and cycling infrastructure are subject to the requirements of the Local Government Act (Department of Internal Affairs, 2002). This includes a requirement to consult with persons who may or will be affected by, or have interest in the proposed changes (Department of Internal Affairs, 2002). Similarly provision of some infrastructure, such as traffic management devices (including infrastructure such as pedestrian crossings), may also require a resource consent in respect to the relevant District Plan rules (under the Resource Management Act) (New Zealand Transport Agency, 2009).

When changing speed limits there is a legal requirement to consult with specific parties, for example, the Police. Generally walking and cycling infrastructure changes do not require a special consultative procedure.

Unlike “Speed Limits New Zealand” (New Zealand Transport Agency, 2003) procedures for calculating the speed limit, there is no (equivalent) specific ‘test’ for providing walking and cycling infrastructure. The legislative requirements for implementing walking and cycling infrastructure are therefore considered to be similar although less restrictive than the requirements for reducing urban speed limits.

7.2.4 Industry knowledge

Reviewing the available literature (refer to section 7.3) suggests that there is ample available international and New Zealand literature, on how to implement walking and cycling infrastructure, but a lack of knowledge of the resultant effects. Most studies available in New Zealand relate to cycle lanes. The impact of cycle lanes on mode-shift and safety identified in these studies are highly variable. The same can be said for international studies and indeed none conclusively allow new cyclist numbers / mode-shift to be determined.

There are significantly more examples of walking and cycling infrastructure in New Zealand than there are examples of reduced urban speeds. The survey results in section 5.3.2 show that New Zealand industry professionals are more than twice as likely to have experience with walking and cycling, than speed-related work. Furthermore, the survey results indicated that respondents considered walking and cycling to be a more achievable method, than reducing urban speeds (refer to section 5.3.5).

That said, knowledge regarding the effects of walking and cycling infrastructure provision is not necessarily any greater than that of the effects of reducing urban speeds. This is despite the survey results suggesting that walking and cycling was considered to be more effective at achieving sustainable land transport outcomes, than reducing urban speeds. It is tentatively suggested that many respondents are simply not aware of how little and inconclusive the research is on the effects of walking and cycling infrastructure. Alternatively (or as well) this may reflect that walking and cycling are commonly considered to fall within the definition of sustainable transport and are thus inherently expected to improve sustainable transport outcomes. In comparison, it is likely that a much greater knowledge of the impacts of reducing urban speed is required to understand the potential contribution to sustainable land transport.

The limited industry guidance available for speed management (refer to section 3.2.4 but primarily Austroads, 2008b and Standards New Zealand, 2010b) is particularly apparent when compared to the industry guidance available for walking and cycling. Walking and cycling industry guidance includes several Austroads Guides, the “Cycle Network and Route Planning Guide” (Land Transport Safety Authority, 2004), “Pedestrian Planning and Design Guide” (New Zealand Transport Agency, 2009), various Traffic Notes (New Zealand Transport Agency, 2013) and also regular industry training courses, for example, the “Fundamentals of planning and design for cycling” course (ViaStrada, 2013).

Overall, it is concluded that, in New Zealand there is generally a greater level of industry knowledge, both in terms of literature and practical experience, on provision of walking and cycling infrastructure, than there is on reducing urban speeds. Knowledge of the effects of both methods is however limited.

7.2.5 Public opinions

New Zealand research undertaken as part of the Hastings Model Communities project includes surveys of public support for walking and cycling. The results of the perceived safety of cycling in Hastings, before (2008) and after (2011) the changes, are shown in Table 12 (Hastings District Council, 2011a).

Table 12: Perceived safety of cycling in Hastings (Hastings District Council, 2011a)

Perception of cycling safety	2008	2011
Safe / very safe	28%	35%
Dangerous / very dangerous	48%	36%

The surveys also considered how favourably walking and cycling was viewed. The results indicated that over 40% of respondents considered walking to be strongly desirable and less than 5% considered it to be strongly un-desirable. Cycling was seen as less desirable than walking, with only 35% stating that they considered cycling to be strongly desirable (Chapman et al., 2012).

Further results suggested that around 23% considered walking to be a social norm, 18% were neutral and 16% disagreed that walking was a social norm. For cycling 13% considered it to be a social norm, 13% were neutral however 30% strongly disagreed that cycling was a social norm. Other questions identified that over 20% of respondents indicated that they had a lack of confidence or lacked the ability to cycle (Chapman et al., 2012).

In terms of intentions to change, about 60% of residents intended to walk more but 21% strongly disagreed that they intended to walk more. 44% of respondents intended to cycle more, however, 41% strongly disagreed that they intended to cycle more (Chapman et al., 2012).

A University of Canterbury travel survey asked respondents to list factors that would encourage them to cycle more. The most frequently cited factors were more courteous motor vehicle drivers, followed closely by less traffic on the roads (both with 14%). More cycle routes was the third most commonly cited (around 12% of responses) (Taylor, 2009). Another survey, of recreational cyclists in New Zealand, also indicated the same three top factors (Taylor, 2009).

None of the above survey results actually consider the level of general public support for provision of walking and cycling infrastructure. It can however reasonably be inferred from the successful implementation of walking and cycling infrastructure, in many cities, that there is at least not strong opposition to this. Indeed there are a number of newspaper articles suggesting that cycling advocate groups (and others) attend council meetings in support of

such infrastructure being provided. For example, Cycle Action Auckland presented to the North Shore City Council on walking and cycling access across the Auckland Harbour Bridge. Following the presentation the council announced its “strong support” for this (North Shore City Council, 2008).

From section 6.1.5 it was determined that all three case studies and the literature review indicated residents support for reducing urban speeds. Despite the lack of information available regarding the level of general public support there is nothing to suggest widespread opposition to reducing urban speeds.

The conclusion in respect to both methods is that it is difficult to gauge the overall level of public support however there is nothing to suggest that the public are opposed to either method.

7.2.6 Political opinion

A greater understanding of the environmental and health benefits of walking and cycling, has led to provision of strategies and plans, to increase walking and cycling at all levels of government in New Zealand. Provision of walking and cycling infrastructure to encourage greater uptake of these modes, has largely been the role of local government assisted by the New Zealand Transport Agency. There is also a national strategy on walking and cycling (Ministry of Transport, 2005) and most local councils have published specific strategies focused on walking and cycling in their area. This focus from central government right through to local government includes specific allocation of funding for active modes (primarily walking and cycling) by the New Zealand Transport Agency and local councils (for example, in long term plans).

Although the focus has shifted slightly away from walking and cycling, with the current government (refer to section 2.3.1), it appears that there is still a more consolidated political stance on provision of walking and cycling infrastructure, than reducing urban speeds.

The awareness of the impacts of speed on safety is growing and may contribute to greater political support for reducing urban speeds. The Hamilton safer speed project shows that political support for reducing urban speeds is possible in New Zealand and that with central and local government support implementation of reduced urban speeds can occur.

To date there appears to be greater political support for walking and cycling infrastructure, however, there is potential for political support for reducing urban speeds to increase to a similar level.

7.3 Comparison of effectiveness

As with the above sections, the effectiveness of walking and cycling infrastructure considers the effects on: safety, accessibility, environmental sustainability, public health, functional transport networks, economic development, and integrated urban form.

7.3.1 Safety

Improving safety is one of the key outcomes sought when providing infrastructure for pedestrians and cyclists. Despite this, New Zealand research into the safety effects of infrastructure provision is still limited. One of the key reasons is the lack of reliable data on crashes, injuries, and kilometres travelled by bicycle and on foot, particularly a lack of reliable before and after studies (Turner et al., 2006). Often at least five years of data is required to draw conclusive findings and as such there can be a considerable delay between installation of infrastructure and research into the safety effects (Buckley & Wilkie, 2000).

Research suggests that around one quarter of pedestrian accidents, and around half of cycle accidents, in New Zealand, do not involve a motor vehicle (Munster et al., 2001). It is difficult to monitor the effects of infrastructure provision on these types of accidents as they are not recorded in the national crash database.

The New Zealand Transport Agency (2009) sets out pedestrian crash reductions associated with different types of pedestrian infrastructure, these are summarised in Table 13.

Table 13: Typical crash reductions from pedestrian infrastructure (New Zealand Transport Agency, 2009)

Measure	Pedestrian crash reduction
Kerb extensions only	36%
Raised median / refuge island	18%
Kerb extensions and raised median	32%
Zebra crossing only	-28%
Zebra crossing on platform	80%
Roundabouts	48%
Mid-block traffic signals	45%
Intersection traffic signals – parallel pedestrian phase	-8%
Intersection traffic signals – exclusive pedestrian phase	29%

In respect to the crash reduction at kerb extensions and refuges the figures were adopted from a New Zealand crash reduction study (Land Transport Safety Authority, 1994). The study considered 60 sites (where there had been previous pedestrian crashes) and identified mean reductions in crash numbers by comparing before, and expected after crash rates, with the actual crash rate observed. Considering the results for each site however showed a large variation from a 100% decrease to a 184% increase, in crash numbers. In total 14 of the 60 sites (23%) had an increase in crash numbers (Land Transport Safety Authority, 1994). Information supporting the other figures in Table 13 appears to be based on international research and the details of these studies are not known.

Cycle lanes are widely considered to improve the perceived safety of cycling, on a particular route, and are one of the most common types of infrastructure provided for cyclists, but again the literature is divided on the safety effects.

One New Zealand study compared the proportion of crashes involving cyclists using certain facilities. The study identified that 48% of crashes occur in the traffic lane, 32% on the road shoulder and 7% in the cycle lane (Munster et al., 2001). On first appearances this could suggest that cycle lanes reduce the crash rate substantially, however, it may simply reflect

the proportion of cycling which occurs on cycle lanes compared to traffic lanes and shoulders.

Two other New Zealand studies (Turner et al., 2009 and Allatt et al., 2012) have found a 10% reduction in cycle crashes, from installation of cycle lanes at midblock locations. A review of cycle lanes in Christchurch also concluded that cycle lanes “almost conclusively reduced” the crash rate, for all road users, at mid-block locations although no percentage reduction figures were specified. They also concluded that there was no significant effect on pedestrian crash rates following installation of cycle lanes (Buckley & Wilke, 2002). New Zealand Transport Agency (2009) however states that international research suggests a 30% safety benefit to pedestrians from installation of cycle lanes (assumably due to additional buffer space provided clear of kerb side car parks).

A before and after study, of 15 arterial roads in Christchurch, where cycle lanes were installed identified an average decrease in accidents involving cyclists of 23%. The change in crashes varied between the sites, one site recorded a 100% decrease whilst another recorded a 196% increase. 9 of the 12 sites showed a reduction in crash numbers (Parsons & Koorey, 2013).

A review of overseas studies on the effects of accident rates from cycle lanes, suggested that they led to a 2% reduction in cycle accidents, a 5% reduction in accidents with vehicles and a 5% reduction in accidents with pedestrians. The review concluded that cycle lanes led to a 4% reduction in all accidents suggesting that cycle lanes can improve general safety, as well as safety to cyclists (Elvik & Truls, 2004). These general safety improvements may reflect reduced lane widths, commonly required in order to retro-fit cycle lanes, on existing roads. The reduction in lane width is observed to reduce the extent to which drivers deviate from and within the lane, and also reduce vehicle speeds (Parsons, 2012).

A New Zealand study estimated that a 5% mode shift from private vehicles to bicycles would be expected to result in an additional 5 cycle fatalities per year (Lindsay et al., 2011). This may however over estimate fatalities as research suggests that there may also be a noticeable ‘safety in numbers’ effect (Turner et al., 2006). A similar effect was also found for increasing pedestrian numbers in New Zealand (Muster et al., 2001). Some halo effects may be observed on other parts of the transport network from a safety in numbers effect but

it is not clear what level of increase is required to have a noticeable ‘safety in numbers’ benefit.

It appears that, whilst provision of infrastructure for pedestrians and cyclists often aims to improve safety, it does not always improve it in all locations. To an extent this may simply reflect the randomness of accidents. Guides on provision of walking and cycling infrastructure often reiterate that the most important contribution to pedestrian and cyclist safety, comes from effective reduction in vehicle speeds (referring to speeds below 40 km/h) (Austroads, 2008b). Comparing the results in section 6.2.16.2 on reducing urban speeds, it would certainly appear that a 10 km/h reduction in speeds (for example, from 50 km/h to 40 km/h) would be likely to have a much more consistent, and possibly larger, safety benefit overall than that resulting from provision of cycle lanes.

Given the wide ranging effects on the crash rate (including increases at some sites) it is considered that further research is required into the safety effects of cycle lanes in New Zealand. Additional research into the safety effect of other pedestrian and cycle infrastructure being used in New Zealand is also required. The lack of research on crash rates for walking and cycling infrastructure in New Zealand is compounded by a general lack of such research internationally.

As outlined in sections 3.4.1, 4.5 and 6.2.1, whilst there are also variations in the extent of crash reductions from reducing urban speeds, there is a reasonably well agreed correlation between reducing speeds and improved road safety. Reducing speed reduces crash severity and the number of crashes involving pedestrian and cyclists. It is therefore concluded that reducing urban speeds would provide at least similar (if not better) improvement in safety, than provision of walking and cycling infrastructure.

7.3.2 Accessibility

Provision of walking and cycling infrastructure typically improves the friendliness of travel via these modes. Appropriate infrastructure should be able to remove or minimise physical barriers for pedestrians and cyclists, for example, providing links across waterways to reduce travel distance.

The “Cycle Network and Route Planning Guide” (Land Transport Safety Authority, 2004) and the “Pedestrian Planning and Design Guide” (New Zealand Transport Agency, 2009)

both identify reducing traffic volumes, and speeds, as a greater priority than infrastructure improvements when considering options to provide for pedestrians and cyclists. This would suggest that generally reducing urban speeds would be comparable, if not more appropriate, for improving accessibility for pedestrians and cyclists. It may also provide a wider range of benefits to more people (for example, increased child play) than provision of a particular walking and / or cycling facility.

7.3.3 Environmental sustainability

They key environmental sustainability effects relate to vehicle emissions, fuel and energy use.

Some infrastructure, for example, raised pedestrian (zebra) crossings may require vehicles to stop or yield to pedestrians. This leads to increased acceleration and deceleration of motor vehicles affecting fuel use and vehicle emissions. In urban areas the opportunities to travel at constant speed are limited but increasing the number of instances where vehicles are required to accelerate and decelerate will increase vehicle emissions (Dyson et al., 2001a). It is anticipated that unless a lot of new infrastructure requiring vehicles to accelerate or decelerate, is installed this will have little noticeable effect overall across a city or even a suburb. The effects also vary based on the type of infrastructure adopted and in this respect the effects are similar to that which could occur as a result of some physical speed reduction devices.

Provision of walking and cycling infrastructure could however reduce vehicle emissions through encouraging mode-shift, and decreasing the amount of motor vehicle travel, particularly for short trips. Research suggests that a 5% mode shift from private cars to walking or cycling could save around 223 million kilometres of travel in New Zealand equating to a saving of around 22 million litres of fuel (Lindsay et al., 2011).

Two studies in the United States of America have considered whether there is a correlation between provision of cycle lanes and the proportion of cycle commuters. The first of these considered 18 cities and used a linear regression model to adjust for variables such as rain days and percent of college students. They found a 0.07% increase in cycle commuting to work, for each additional mile of cycle lanes per 100,000 people (Nelson & Allen, 1997). The second study considered 35 larger cities and found a 1% increase in the proportion of

workers commuting by cycle for each additional mile of cycle lanes per square mile (Dill & Carr, 2003). The problem with both these studies is that they do not confirm a cause and effect relationship. A higher number of cyclists may have encouraged provision of cycle lanes rather than the cycle lanes encouraging more cyclists.

Before and after studies of cycle lanes in Copenhagen suggests a 5% increase in cycle mileage and 1% decrease in motor vehicle mileage but these changes were not considered to be statistically significant. Similar studies of separated cycle paths noted a 20% increase in cycle mileage and a 10% decrease in motor vehicle mileage (Jensen, 2007).

McDonald et al. (2007), sought to review international methods for estimating demand for new cycling facilities and to develop a tool for estimating cycle demand for New Zealand (LTNZ) funding applications. 10 sites within New Zealand were selected to assist with development and testing of the tool. Two tools were developed, one for on-road and one for off-road facilities. Both tools included an allowance for new cyclists immediately attracted to the facility, and annual growth rates (McDonald et al., 2007).

The off-road tool suggests that the number of new cyclists will be (McDonald et al., 2007):

$$\text{Number of new cyclists} = 1.6 \times \sqrt{(\% \text{ people travel to work by bike} \times \text{motor vehicle volume on road parallel to off road path}) + \text{half the existing cycle volume on road parallel to the off road path before installation of the path.}}$$

For on-road facilities they suggest that new cyclists will be 20% of the existing cycle AADT and that annual growth rates will be the average of the annual growth rate of trips to work by cycle (from Census data) and the default growth rate of 8%. The 8% growth rate is determined from the following four New Zealand examples (McDonald et al., 2007).

Table 14: Data from examples used to determine default 8% growth rate (McDonald et al., 2007)

Locations	AADT at Installation	AADT (2007)	Years Facility Installed	Annual Growth
Centaurus Road, Christchurch	508 ²	702	3	11.4%
Halswell Road, Christchurch	565 ²	548	3	-1.0%
Wakefield Quay, Nelson	357	455	8	3.1%
North Road, Dunedin	242	347	2	19.9%
Average of Annual Growth				8.3%
Weighted Average of Annual Growth				7.7%

Whilst the tool meets the objective, of developing a consistent approach to estimating demand for funding applications, the reliability of the mode shift estimates is questionable. For example, looking solely at the data in Table 14 above (used to generate the 8% default annual growth rate), the actual annual growth rates varied between the four sites. One site showed an 1% decrease and another showed a 19.9% increase (McDonald et al., 2007). Indeed the authors caution that much more research is required and that the tool should be refined once more before and after data is available. Particularly they note that neither the on or off road tools have been validated (McDonald et al., 2007).

Before and after studies of 15 arterial roads in Christchurch considered the change in cyclist numbers both immediately after (step change) and in the years following, the installation of cycle lanes (Parsons, 2012). The results are shown in Table 15.

Table 15: Cycle growth rates pre and post cycle lane treatments (Parsons & Koorey, 2013)

Corridor	Growth Rate - Cycles p/a			Step Change	Pre/Post Change
	Pre	Step	Post		
Blighs Road	-55	-24	+3	+31 (+56%)	+58 (+105%)
Centaurus Road	+4	+33	+15	+29 (+725%)	+11 (+275%)
Greers Road	-26	+49	+2	+75 (+288%)	+28 (+106%)
Hoon Hay Road	-32	+18	+8	+50 (+156%)	+40 (+125%)
Lincoln Road	-7	+36	+31	+43 (+614%)	+38 (+542%)
Lyttelton Street	+41	-187	+40	-228 (-556%)	-1 (-2%)
Moorhouse Avenue	-25	+201	+53	+226 (+904%)	+78 (+312%)
New Brighton Road	+6	-98	-18	-104 (-1733%)	-24 (-400%)
Pages Road	0	-26	-13	-26 (-)	-13 (-)
Strickland Street	+35	-42	+23	-77 (-220%)	-12 (-34%)
Wainoni Road	-13	-191	-6	-178 (-1369%)	+7 (+54%)
Wairakei Road	-16	-60	-18	-44 (-275%)	-2 (-13%)
Total	-88	-291	+120	-203 (-231%)	+208 (+236%)
Creyke-Kilmarnock Route		+6			
Marshland Road		-22			
Milton Street		+3			

The study concludes that the immediate change (step change) in cycle numbers has been negative (a decrease in cycle numbers). On this basis the validity of the assumed step change in the above estimation methods is questioned (Parsons and Koorey, 2013).

The longer term change in cycle numbers resulted in a weighted average increase of around 200%. There was a large variation between routes, one showed a 400% decrease, and another a 542% increase, in cycle numbers (Parsons & Koorey, 2013). It is noted that 5 of the 12 sites where long term trends were considered, had a decrease in cycle numbers. On this basis, the conclusion that the overall change in cycle rates has been ‘strongly positive’, may be a little premature. Given the variation in results, it is possible that a larger sample number may be required before an average result provides a reliable indication of the effects of cycle lane treatments.

Partial results from the Hastings Model Communities project (15 out of the 37 sites), show a 23% increase in the number of cyclists, as a result of the programme initiatives (Hastings District Council, 2011b).

In terms of considering mode shift it must be noted that even the sites showing increases in cyclist numbers do not necessarily represent new or additional cycle trips. They may instead represent a shift in routes from an existing trip on an adjacent road. The City of San Francisco counted cyclist numbers on adjoining streets after implementation of cycle lanes

and found that cyclists were diverted to the cycle lane (Pucher et al., 2010). Population increases could also be a factor when longer term trends are considered.

There is very little information available on the changes in pedestrian numbers as a result of the provision of new infrastructure. One study, of street redesigns in the United Kingdom, which sought to support place functions of roads as well as their movement function, found pedestrian movements increased by 174% at Sheaf Square and Howard Street, Sheffield, and 56% on weekdays and 29% on Saturdays at Maid Marian Way in Nottingham (CIHT, 2010). It is however likely that (as with cycle lanes) results would vary considerably from location to location and depending on the type of facilities provided.

Even within the different methods of considering mode shift there are differing results. Boulder, Colorado increased its share of workers commuting via bicycle from 3.8% in 1980 to 6.9% in 2000. In Davis, California the share of bicycle commuters to work fell from 28% in 1980 to 14% in 2000 despite provision of extensive bikeways and bike parking. This shows that other factors may have a stronger impact on mode share than provision of infrastructure (Pucher et al., 2010).

Provision of infrastructure for pedestrians and cyclists has the potential to increase the number of people walking or cycling and there are a number of examples where this has occurred. Unfortunately there are also a number of cases where research suggests numbers have declined. Even where the number of cyclists increased, the studies do not necessarily indicate mode shift as users may have been diverted from other routes.

Overall whilst it is likely that providing walking and cycling infrastructure will achieve mode shift in New Zealand, this cannot conclusively be determined based on the research available. A lack of conclusive research also led to the same conclusion in respect to whether reducing urban speeds can contribute to mode shift. It is therefore not possible to conclude which method would be more effective at achieving environmental sustainability related outcomes.

7.3.4 Public health

Walking and cycling infrastructure is unlikely to have any noticeable noise-related effects. Generally, on roads with less than 2,000 vehicles per day, traffic noise is associated with individual vehicles (Standards New Zealand, 2010b). On higher volume roads in urban areas,

a 10% reduction in traffic leads to only a 0.5 dB decrease in noise, which would not be noticeable (Bendtsen et al., 2000). Given provision of infrastructure cannot necessarily be expected to result in mode-shift, no noticeable reduction in noise would be likely to occur. For comparison section 6.2.4 concluded that reducing urban speeds can achieve a noticeable (over 1 dB) change in traffic noise although this is dependent on the change in speeds achieved.

The safety-related health effects (fatalities and injuries) have been considered separately. In terms of physical activity related effects, the discussion in section 7.3.1 indicated that there is a clear link between increased physical activity and health benefits but such benefits are only realised through mode-shift or increased recreational activity. Similarly any public health benefits due to reduced air pollution rely on mode-shift to decrease vehicle travel. Given the inconsistent findings on the impact on mode-shift it is difficult to determine whether any such effects would occur.

Overall, it is concluded that both provision of walking and cycling infrastructure and reducing urban traffic speeds could contribute to public health benefits. Reducing urban speeds is likely to have a greater benefit in terms of reducing noise, but effects associated with increasing physical activity or improving air pollution related health effects, rely upon mode-shift. Given the uncertainty over whether either of the methods would achieve mode-shift it is concluded, at this stage, that in terms of public health, reducing urban speeds would be at least as effective as provision of walking and cycling infrastructure.

7.3.5 Functional transport networks

Some pedestrian and cycle infrastructure could cause delay to vehicles where priority is afforded to pedestrians or cyclists. This is similar to that which could occur at some physical speed reduction measures, however, reducing speeds, regardless of the method used, also slightly increases travel times.

A mode-shift from vehicle travel to walking and / or cycling could reduce the distance travelled by motor vehicles and therefore reduce congestion. As outlined above, it is not possible to conclude which method would more effectively achieve mode-shift.

In respect to reducing urban speeds, it was concluded above that, this may result in some dis-benefits associated with increased travel times however these are likely to be small. Overall

therefore the key aspect in terms of functional transport networks, for both methods, is likely to depend on mode-shift. In this respect there is insufficient information to determine which method would be more effective at achieving outcomes related to functional transport networks.

7.3.6 Economic development

Provision of walking and cycling infrastructure may result in increased foot traffic and some positive economic benefits for local businesses (refer to section 3.4.6). Other than potential delays where motor vehicles may have to yield to pedestrians or cyclists, there is not likely to be any economic costs associated with increased travel times.

The safety benefits of walking and cycling infrastructure considered in section 7.3.1 were less consistent than that from reducing urban speeds (section 6.2). On this basis, the social cost savings (from reduced injuries and fatalities) from provision of walking and cycling infrastructure may not be as large as that from reducing urban speeds. This would suggest that on balance, the effects of providing walking and cycling infrastructure on economic development would be similar to that resulting from reducing urban speeds.

7.3.7 Integrated urban form

The effects on integrated urban form include: the integration of the street with the adjoining land use, liveability of the street and the amount of land required for transport.

Walking and cycling infrastructure is often retro-fitted within existing street scapes. Other than provision of off-road paths or creation of new roads (i.e., subdivisions) that have additional width to accommodate specific infrastructure, there is unlikely to be any effect on the amount of land required for transport. If anything, providing dedicated walking and cycling infrastructure could increase the amount of land required for transport.

Pedestrianisation of streets and provision of some ancillary infrastructure, for example, street trees, may however contribute to improving the livability of a street (Dumbaugh, 2005). Improving the liveability of a street can enable better use of the road corridor and better match the needs of adjoining land uses, for example, improved amenity in residential areas (Moudon & Appleyard, 1987).

Overall, provision of walking and cycling infrastructure and reducing speeds can both contribute to the improved liveability of the street and enable better integration of land use and transport. Reducing urban speeds has a greater potential to enable the reduction in the amount of space required for transport, however, the extent to which this would be given effect to is unclear. It can however be concluded that both methods can provide a small positive effect on integrated urban form.

7.4 *Summary of comparative analysis*

This section compared the effectiveness and efficiency of reducing urban speeds with that of providing walking and cycling infrastructure, in terms of the potential for each method to achieve more sustainable land transport outcomes in New Zealand.

In terms of efficiency, it is considered that provision of walking and cycling infrastructure is currently more efficient than reducing urban speeds given the greater level of knowledge, experience with implementation, level of political support, and slightly less restrictive legislation. It is however considered that there is no reason that reducing urban speeds could not be as efficient as provision of walking and cycling infrastructure once greater political support, more guidance on using “Speed Limits New Zealand” and more experience with implementation, is gained. Conclusions on the comparison of the two methods in terms of public support and time and costs, are not possible from the information currently available.

In terms of effectiveness, it is concluded that reducing urban speeds would provide at least similar (if not better) improvements in: safety, accessibility, integrated urban form, and economic development, as provision of walking and cycling infrastructure.

The relative effects of public health, environmental sustainability, and functional transport networks, all depend on whether, or the extent to which, mode-shift is likely to result. From the available research it is not possible to determine whether providing walking and cycling infrastructure or reducing urban speeds, will achieve mode shift. It is therefore not possible to conclude which method would be more effective. There is nothing to suggest that reducing urban speeds would be less likely to achieve these outcomes, than provision of walking and cycling infrastructure.

Overall, from the information available to date, it is concluded that reducing urban speeds is at least as effective as provision of walking and cycling infrastructure at achieving

sustainable land transport outcomes in New Zealand and has the potential to be achieved as efficiently in the future.

8 Conclusions and Recommendations

8.1 *Aims, objectives and hypothesis*

The aim of this research was to determine whether reducing urban speeds¹⁸ could achieve sustainable land transport outcomes sought in New Zealand in a more effective and efficient way, than current methods being undertaken to achieve these outcomes.

In order to achieve this aim, four key objectives were developed:

1. To identify the key sustainable land transport outcomes sought within New Zealand and the methods being undertaken to achieve them;
2. To consider the likely contribution of reducing urban speeds towards achieving the sustainable land transport outcomes;
3. To consider industry and public perception of reducing urban speeds; and,
4. To compare the effectiveness and efficiency of reducing urban speeds to achieving sustainable land transport outcomes, relative to current methods being undertaken.

The aims and objectives of this research have been met. Section 2 considers the sustainable land transport outcomes sought in New Zealand and the methods being undertaken to achieve them. Particularly seven key sustainable land transport outcomes (safety, accessibility, environmental sustainability, public health, functional transport networks, economic development, and integrated urban form) were identified and considered throughout the literature review, case studies, survey and comparative analysis.

In respect to the third objective, the survey contributes to the understanding of industry professionals perception of reducing urban speeds. Only very limited progress was made towards considering public perception of reducing urban speeds and this is an area identified for further research.

In respect to the fourth objective a comparative analysis was undertaken of the potential effectiveness and efficiency of reducing urban speeds, compared to that of providing walking and cycling infrastructure. Walking and cycling infrastructure was chosen as the method for

¹⁸ Reference to reducing urban speeds is referring to the concept and not to particular types of streets or at a set scale.

the comparison given its prevalent use in Hamilton and Wellington sustainable land transport related strategies reviewed.

The following section outlines how the findings partly confirm the hypothesis (that reducing urban speeds could contribute to a variety of sustainable land transport outcomes, some more than others, but overall would be comparably effective and efficient at achieving sustainable land transport outcomes, when considered against other methods commonly used).

8.2 Key findings

It is clear from central and local government strategies that sustainable land transport is an important consideration in New Zealand. There is no widely used definition of sustainable land transport, however some key components include: safety, accessibility, environmental sustainability, public health, functional transport networks, economic development, and integrated urban form.

Consideration of Wellington and Hamilton Councils sustainable land transport related strategies suggests that walking and cycling infrastructure, advertising education or awareness campaigns, road safety improvements, and public transport, were the most common methods identified to achieve sustainable land transport outcomes. Reducing urban speed was identified in only approximately 24% of the strategies reviewed and was considered solely as a method to achieve safety-related outcomes.

The survey of industry professionals identified that reducing urban speeds was considered to be one of the least effective methods for achieving sustainable land transport. Provision of walking and cycling infrastructure and improving public transport, were considered to be the most effective methods. Reducing urban speeds was not considered particularly easy or difficult to implement. Advertising, education or awareness campaigns, were considered the easiest method to implement, and fuel or vehicle mileage taxes the most difficult.

There was some relationship between the frequency of use of methods adopted in Wellington and Hamilton strategies and the average of the effectiveness and efficiency ratings from the survey. This appears to support the assumption that both the effectiveness and efficiency of methods is central to understanding why they may, or may not, be adopted by local councils in New Zealand.

8.2.1 Potential efficiency of reducing urban speeds

Key factors considered to affect efficiency of implementing methods to achieve sustainable land transport outcomes include: ability to successfully implement, time and cost, legislation, industry knowledge, public opinion, and political opinion. The influence of each of these aspects on the potential efficiency of reducing urban speeds has been considered.

It is concluded that lower urban speeds can be successfully implemented in New Zealand, for example, eight Safer Speed Areas (40 km/h) have been established in Hamilton.

The survey results indicated that time and cost were anticipated to restrict the ability to achieve reduced urban speeds. Reduced speed areas established in Hamilton and Wellington however show that time and cost requirements are achievable.

Legislation permits lower urban speeds to be implemented in New Zealand but the slow uptake of lower speed areas and comments from the industry professionals survey, suggest that additional guidance should be provided, to assist road controlling authorities with the legislative process.

There is a general lack of experience and research, on reducing urban speeds in New Zealand, which is contributing to a lack of industry knowledge. There is a particular lack of knowledge regarding perceived dis-benefits on fuel usage, vehicle emissions, and travel time, from reducing urban speeds.

Public and political opinions are difficult to gauge, but survey information from Auckland (Point England) and Hamilton shows support from residents. Political support for reducing urban speeds varies by local authority and appears to be important in the uptake of lower speed limits. Comparing the results of the survey with the literature review and case study findings, it is possible that industry professionals may be under estimating the level of political and public support.

When compared to provision of walking and cycling infrastructure, reducing urban speeds is currently a less efficient method. The key reasons that walking and cycling infrastructure is more efficient relate to a greater level of knowledge, experience, and political support, and slightly less restrictive legislation. There is however no apparent reason that reducing urban speeds could not be as efficient, as provision of walking and cycling infrastructure, with

greater political support, more guidance on using the current legislation and an improvement in the level of industry knowledge.

Overall, in terms of efficiency the key limitations in New Zealand appear to be associated with the existing legislative process and a lack of industry knowledge. A greater understanding of political and public opinion would also assist.

8.2.2 Potential effectiveness of reducing urban speeds

Considering the effectiveness of a method to achieve sustainable land transport related outcomes includes the potential effects on: safety, accessibility, environmental sustainability, public health, functional transport networks, economic development, and integrated urban form.

There is a high level of consistency in respect to the findings on safety. It is concluded that reducing urban speeds would lead to the number of crashes reducing, particularly crash severity, and crashes involving pedestrians and cyclists.

There is a high level of consistency between the survey, case study and literature review findings in respect to accessibility. It is concluded that reducing urban speeds is likely to increase accessibility for walking and cycling (for existing users, even if no mode shift is achieved).

In terms of environmental sustainability, more accurate methods of measuring vehicle emissions and fuel use, than the models previously used, suggest that there is not likely to be any noticeable change in either vehicle emissions or fuel use. The survey results suggest that many industry professionals are unaware of this research. There was a broad range of survey responses, however, the results suggested that vehicle emissions and fuel usage were anticipated to slightly increase as a result of reducing urban speeds.

It is likely that reducing urban speeds may contribute to mode shift, but there is insufficient evidence to determine whether this is the case. Overall, reducing urban speeds would likely contribute to environmental sustainability related outcomes, however, the contribution would be less certain than say the effects on safety.

In terms of public health, reducing urban speeds is likely to decrease noise. Although overall vehicle emissions are not likely to noticeably change, small reductions in some vehicle

emissions (nitrogen oxides and particulate matter) that are considered to be particularly harmful, may contribute to improving public health. There would also be accident cost savings and some health benefits (from increased physical exercise if mode-shift occurred or if more liveable streets encouraged increased play / active recreation). Overall, public health would be likely to improve as a result of reducing urban speeds.

In terms of functional transport networks, travel times are only likely to increase to a small degree and not proportionately to the reduction in speed. The survey results suggested that industry professionals may be over-estimating the impact of reducing urban speeds on travel times. There may also be some benefits from reducing urban speeds, for example, reduced congestion. Overall, it is concluded that reducing urban speeds would not contribute towards achieving functional transport outcomes due to the impact on travel times, however, any dis-benefits are considered to be small in comparison to some of the other (for example, safety) benefits.

In terms of economic development, the increase in travel times is not likely to have a significant effect on the cost of transport (and therefore the cost of goods) and may be off-set by some localised benefits for businesses (from increased foot traffic). A reduction in crashes could also have a noticeable social cost saving and total benefits are likely to outweigh total costs. On balance therefore reducing urban speeds is considered to contribute to economic development.

Reduced urban speeds is likely to improve the liveability of residential areas and may also make more efficient use of space, and is therefore likely to contribute to more integrated urban form.

When compared to the effectiveness of providing walking and cycling infrastructure, the relative effects on public health, environmental sustainability, and functional transport networks, all depend on whether, or to what extent mode-shift is likely to result. From the available research it is not possible to determine whether providing walking and cycling infrastructure or reducing urban speeds, will be more effective at achieving mode shift.

Reducing urban speeds would provide at least similar (if not better) improvements in safety than provision of walking and cycling infrastructure.

Industry design guidance (refer to section 3.2.4) sets out that reducing speeds is a greater priority than infrastructure improvements, when providing for pedestrians and cyclists. Generally therefore reducing urban speeds would be a comparable, if not more appropriate method, for improving accessibility.

Both methods may result in increased foot traffic and some positive economic benefits for local businesses. Reducing urban speeds may result in a greater increase in travel times than provision of walking and cycling infrastructure: however, the safety benefits of walking and cycling infrastructure considered in section 7.3.1 were less consistent. On balance the effects of both methods on economic development are similar.

Provision of walking and cycling infrastructure and reducing urban speeds can both contribute to the improved liveability of the street and enable better integration of landuse and transport. Reducing urban speeds has a greater potential to enable the reduction in the amount of space required for transport, however, the extent to which this would be given effect to is unclear. Both methods are likely to result in a small positive effect in terms of integrated urban form

It is therefore concluded that reducing urban speeds could contribute to sustainable land transport by improving safety, would likely contribute in terms of public health, accessibility, integrated urban form, environmental sustainability, and economic development. The small dis-benefits in terms of functional transport networks are not likely to be significant in the context of the benefits from the other building blocks. From the information available to date, it is concluded that reducing urban speeds is at least as effective as provision of walking and cycling infrastructure.

8.2.3 Overall conclusions

Overall, reducing urban speeds can effectively and efficiently contribute to achieving sustainable land transport outcomes in New Zealand. Currently, from the information available, this would be as effective as providing infrastructure for pedestrians and cyclists although further research on the potential of both methods to achieve mode-shift is recommended.

Provision of infrastructure for pedestrians and cyclists can currently be undertaken more efficiently in New Zealand, than reducing urban speeds. There is however no apparent

reason that reducing urban speeds could not be as efficient as provision of walking and cycling infrastructure, in the future.

In this respect the hypothesis is confirmed in terms of reducing urban speeds contributing to a variety of sustainable land transport outcomes and doing so as effectively, as provision of walking and cycling infrastructure.

The hypothesis is however dis-proved in terms of reducing urban speeds being comparably efficient, as provision of walking and cycling infrastructure. In terms of the relative efficiency there is currently a greater level of knowledge, experience, political support, and slightly less restrictive legislation for provision of walking and cycling infrastructure. The key aspects to improve the efficiency of reducing urban speeds relate to guidance on the existing legislative process and a lack of industry knowledge. A greater understanding of political and public opinion would also assist.

8.3 Recommendations

This research has identified a number of areas where there is a deficiency in the information available. From the conclusions above two areas have been identified as the most critical to better understanding and / or improving the effectiveness and efficiency of reducing urban speeds in New Zealand. The research has also identified a need for development of industry guidance on using the current legislation and for industry training on provision of lower urban speeds.

The two key areas for additional research are outlined below.

1. Surveys of general public opinion and political opinion, on reducing urban speeds.

The industry professionals survey identified that general public opinion and political opinion may restrict the implementation of lower urban speeds. The literature review and case studies did not, however, identify any indications that this was the case. Whilst there is some survey data available on residents' opinions there is none on general public and / or political opinions.

Industry professionals may be under estimating the level of general public and political support and therefore over-estimating the barriers to implementing lower urban speeds. A better understanding of public and political opinions could help to identify why lower urban speeds are not being more commonly used to achieve sustainable land transport outcomes.

2. Research into the potential for reducing urban speeds to achieve mode-shift in New Zealand.

There is little research internationally and particularly in New Zealand on the effects of reducing urban speeds, on mode-shift. This likely reflects the difficulties in measuring changes in mode-shift.

In terms of potential effects, mode-shift could contribute to environmental sustainability, public health, functional transport networks, and potentially economic development related outcomes. The potential for wide ranging benefits makes understanding the likelihood of mode-shift central to gaining a more accurate understanding, of the extent to which reducing urban speeds could contribute to achieving more sustainable land transport. Understanding the likelihood of modeshift is also central to comparing the potential effectiveness of reducing urban speeds with other methods, such as provision of walking and cycling infrastructure.

The research has also lead to two recommendations for the transport industry. These are outlined below.

1. Development of guidance for applying Speed Limits New Zealand (New Zealand Transport Agency, 2003) to speeds below 50 km/h.

The industry professionals survey identified that, although current New Zealand legislation permits lower speed limits, professionals perceived the current legislation as restricting their ability to implement lower urban speeds. The literature review also identified a lack of guidance on how to achieve speed limits below 50 km/h. There is potential for such industry guidance to contribute to greater uptake of lower urban speeds by reducing the perception of legislation being a barrier to implementation. It

is therefore recommended that some industry guidance on achieving speed limits of less than 50 km/h, be developed.

2. Offer industry training courses on achieving, and understanding, the effects of lower urban speeds.

The research identified a lack of industry knowledge regarding the potential effects of reducing urban speeds. This suggests that training covering: the latest research on how to achieve lower speeds, the benefits and costs of reducing speeds, and New Zealand case studies, would assist with the development of industry knowledge. Of particular benefit would be some focus on areas where professionals were found to be over-estimating the impacts of reducing speeds including travel time, vehicle emissions, and fuel usage. Information on public and political opinions identified in the New Zealand case studies would also be useful.

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Appendix 1: Wellington and Hamilton Strategy Outcomes

Strategy/ Policy document	Number of outcomes related to:						
	Safety	Functional trans. networks	Economic development	Public health	Integrated urban form	Environmental sustainability	Accessibility
Wellington Regional Land Transport Strategy (2010-40)	3	3	3	1	1	3	4
Wellington Regional Walking Plan (2008)	1	-	-	1	-	2	1
Wellington Cycling Policy (2008)	1	-	-	-	1	2	2
Wellington City Council Walking Policy (2008)	1	-	-	2	2	3	1
Wellington City Council Transport Strategy (2006)	1	1	1	1	2	3	2
Wellington City Council Parking Policy (2007)	1	1	1	-	3	3	1
Waikato Regional Land Transport Strategy (2011)	1	2	1	1	4	2	4
Walking and Cycling Strategy for the Waikato Region (2009)	1	1	1	1	1	2	5
Road Safety Strategy for the Waikato Region (2009)	5	-	-	-	-	-	-
Hamilton Travel Demand Management Action Plan (2010)	-	-	-	-	2	2	-
Hamilton City Council Transport Safety Action Plan (2010)	3	-	-	-	-	-	-
Hamilton City Council Active Travel Action Plan (2010)	3	-	-	1	-	3	4
Hamilton City Council Activity Management Plan (2010)	1	2	-	-	2	1	1
Hamilton City Council Passenger Transport Action Plan (2010)	-	2	-	-	-	2	4
Hamilton City Council Network Action Plan (2010)	-	1	-	-	2	1	1
Total	22	13	7	8	20	29	30
Proportion (%)	17	10	5	6	16	22	23

Appendix 2: Wellington and Hamilton Strategy Methods

Strategy / policy document	Method										
	Walking / cycling infrastructure	Parking management	Improved network efficiency / management	Improved vehicle fuel/ energy efficiency standards	Fuel or vehicle mileage charges	Improved public transport	Reduced urban speeds	Travel plans	Law enforcement	Road safety improvements	Advertising, edu. or awareness campaigns
Wellington Regional Land Transport Strategy	√		√	√	√	√	√	√		√	√
Wellington Walking Plan	√							√		√	√
Wellington Cycling Policy	√					√	√	√	√	√	√
Wellington City Council Walking Policy	√	√				√	√	√	√	√	√
Wellington City Council Transport Strategy	√	√				√				√	√
Wellington City Council Parking Policy	√	√				√					
Waikato Regional Land Transport Strategy	√		√		√	√			√	√	√
Waikato Regional Land Transport Programme	√		√			√			√	√	√
Waikato Walking and cycling strategy	√							√		√	√
Waikato Road Safety Strategy							√		√	√	√
Hamilton City Council TDM	√	√	√			√					√

Strategy / policy document	Method										
	Walking / cycling infrastructure	Parking management	Improved network efficiency / management	Improved vehicle fuel/ energy efficiency standards	Fuel or vehicle mileage charges	Improved public transport	Reduced urban speeds	Travel plans	Law enforcement	Road safety improvements	Advertising, edu. or awareness campaigns
Action Plan											
Hamilton City Council Transport Safety Action Plan										√	√
Hamilton City Council Active Travel Action Plan	√								√	√	√
Hamilton City Council Activity Management Plan	√		√							√	
Hamilton City Council Passenger Transport Action Plan						√					√
Hamilton City Council Network Action Plan	√		√			√				√	
Hamilton City Council Parking Management Action Plan		√						√			√
Total	13	5	6	1	2	10	4	6	6	13	14
Percent	76	29	35	6	12	59	24	35	35	76	82

Appendix 3: Survey Questions

Sustainable transport opinions of transport industry professionals

[Exit this survey](#)

Survey information

Thank you for taking the time to complete this questionnaire for my research thesis (Masters of Engineering (Transport) at the University of Canterbury).

You are not required to answer all questions, you will only be able to view one page at a time and once you have completed that page you will not be able to change your answers.

It is anticipated that you will be able to complete this survey in approximately 5-10 minutes. You can save your responses and return to complete the survey at any time so long as you are using the same computer.

By completing this questionnaire it will be understood that you have consented to participating in this research study and that you consent to the publication of the results on the understanding that complete anonymity will be preserved.

Should you wish to be entered in the optional prize draw to win a \$50 Whitcoulls voucher, please enter your contact details at the end of the survey. Your contact details will be separated from your survey responses.

Thank you for your participation. Should you wish to contact me or my supervisor (Dr. Glen Koorey, our contact details are listed below:

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1. Please indicate how many years experience you have in the industry

(select one of the options below)

- ☐ 0-2 years
- ☐ 3-5 years
- ☐ 6-10 years
- ☐ 11-20 years
- ☐ 21-40 years
- ☐ 41 years or more

2. Please indicate which of the following areas of sustainable transport work have you been involved in

(select as many options as applicable)

- ☐ Walking / cycling
- ☐ Effects of transport on the natural environment (e.g. air, water)
- ☐ Effects of transport on the human environment (e.g. noise, social severance)
- ☐ Vehicle / fuel efficiency
- ☐ Public transport
- ☐ Local area traffic management (e.g. traffic calming)
- ☐ Speed (e.g. speed limits or speed management)
- ☐ Travel demand management (e.g. mode shift, travel plans, behaviour change)
- ☐ Road safety

Other (please specify)

3. Please indicate which sectors of the industry have you worked in

(select as many options as applicable)

- ☐ Consultant engineer
- ☐ Consultant other (e.g. planner, policy analyst)
- ☐ Local government engineer
- ☐ Local government other (e.g. planner, policy analyst)
- ☐ Central government engineer
- ☐ Central government other (e.g. planner or policy analyst)
- ☐ Academic

Other (please specify)

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4. Assume the following sustainable transport methods have been implemented, rate how effective you think each option will be at achieving sustainable land transport (i.e., objectives related to environmental sustainability, accessibility, public health, functional transport networks, economic development, integrated urban form and safety).

(choose one answer from the scale along the top for each outcome listed)

	1 (Very ineffective)	2	3	4	5	6	7 (Very effective)
Walking / cycling infrastructure (e.g. cycle lanes, pedestrian refuge islands)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Parking Management (e.g. parking charges)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved network efficiency / network management (e.g. road projects to reduce congestion)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved vehicle, fuel or energy efficiency standards (e.g. kilometres of travel per litre of petrol)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fuel or vehicle mileage taxes (e.g. road pricing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved public transport (e.g. reliability and frequency of buses, bus stops)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduced urban speeds (e.g. to below 50km/h)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Travel Plans (e.g. to manage the amount of travel for a community or organisation)

Law enforcement (e.g. of illegal parking across cycle lanes)

Road safety improvements (e.g. physical changes to a road to reduce crashes)

Advertising, education or awareness campaigns (e.g. awareness of travel alternatives)

Comments

--

5. Rate the following sustainable transport methods in terms of how achievable you think they would be to implement in urban areas of New Zealand (i.e., considering current political and public opinions and practical and technical aspects of implementation)

(choose one answer from the scale along the top for each outcome listed)

	1 (Very difficult)	2	3	4	5	6	7 (Very easy)
Walking / cycling infrastructure (e.g. cycle lanes, pedestrian refuge islands)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Parking Management(e.g. parking charges)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved network efficiency / network management (e.g. roading projects to reduce congestion)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved vehicle, fuel or energy efficiency standards (e.g. kilometres of travel per litre of petrol)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fuel or vehicle mileage taxes (e.g. road pricing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved public transport (e.g. reliability and frequency of buses, bus stops)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduced urban speeds (e.g. to below 50km/h)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Travel Plans (e.g. to manage the amount of travel for a community or organisation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Law enforcement (e.g. of illegal parking across cycle lanes)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Road safety improvements (e.g. physical changes to a road to reduce crashes)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Advertising,
education or
awareness
campaigns (e.g.
awareness of travel
alternatives)

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6. Now we would like you to consider the policy of reducing urban speeds to below 50km/h. This could be achieved by a variety of methods for example, speed limits and or physical measures

Rate how you think reducing urban speeds (to below 50km/h) could affect on the following outcomes

(choose one answer from the scale along the top for each outcome listed - generally less is improved except for the last three options where less is worse)

	1 (worsen)	2	3	4	5	6	7 (improve)
Crash severity (less severe = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of motor vehicle crashes (less crashes = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of crashes involving cyclists or pedestrians (less crashes = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of incidents of crime / feeling of insecurity (less incidents = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Level of vehicle emissions (less emissions = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fuel usage of vehicle (less fuel per kilometre of travel = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Amount of traffic generated vibrations / noise (less vibrations / noise = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	1 (worsen)	2	3	4	5	6	7 (improve)
Amount of motor vehicle travel (less motor vehicle kilometres = improved)							
Number of people choosing to drive rather than walk or cycle (less people driving = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Amenity (more pleasant = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Travel time (less time to undertake a journey = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Travel choices (more choices = improved)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Comment

7. Rate the following options in terms of how much you think they may currently restrict or facilitate the achievement of reduced urban speeds (speeds below 50km/h) in New Zealand

(choose one answer from the scale along the top for each outcome listed)

	1 (restrict)	2	3	4	5	6	7 (facilitate)
Political opinion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Residents' opinion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Public opinion (generally i.e., other than immediate residents)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enforceability of reduced speeds	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to monitor changes / effects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cost / budgets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Expertise / industry knowledge	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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8. Do you consider reducing urban speeds to less than 50km/h would contribute to more sustainable land transport?

(Select one option and explain why you have selected this option)

- ☐ Definitely will
- ☐ Probably will
- ☐ Unsure
- ☐ Probably won't
- ☐ Definitely won't

Please explain why you have selected the answer above

9. Given your responses to the questions above indicate what your recommendation would be for each of the following scenarios

(note that reduced speeds refers to speeds less than 50km/h)

(choose one answer from the scale along the top for each outcome listed)

	1 (Strongly oppose)	2	3	4	5	6	7 (Strongly support)
Reduced speeds of a whole urban area (i.e., all roads within the urban limits)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduced speeds in urban residential areas (i.e., roads within living zones only)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduced speeds on urban local roads (i.e., excluding classified roads such as arterial roads)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduced speeds in high pedestrian areas (i.e., near local shops, schools, central city)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduced speeds in localised business areas (i.e., central city, suburban shopping areas)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

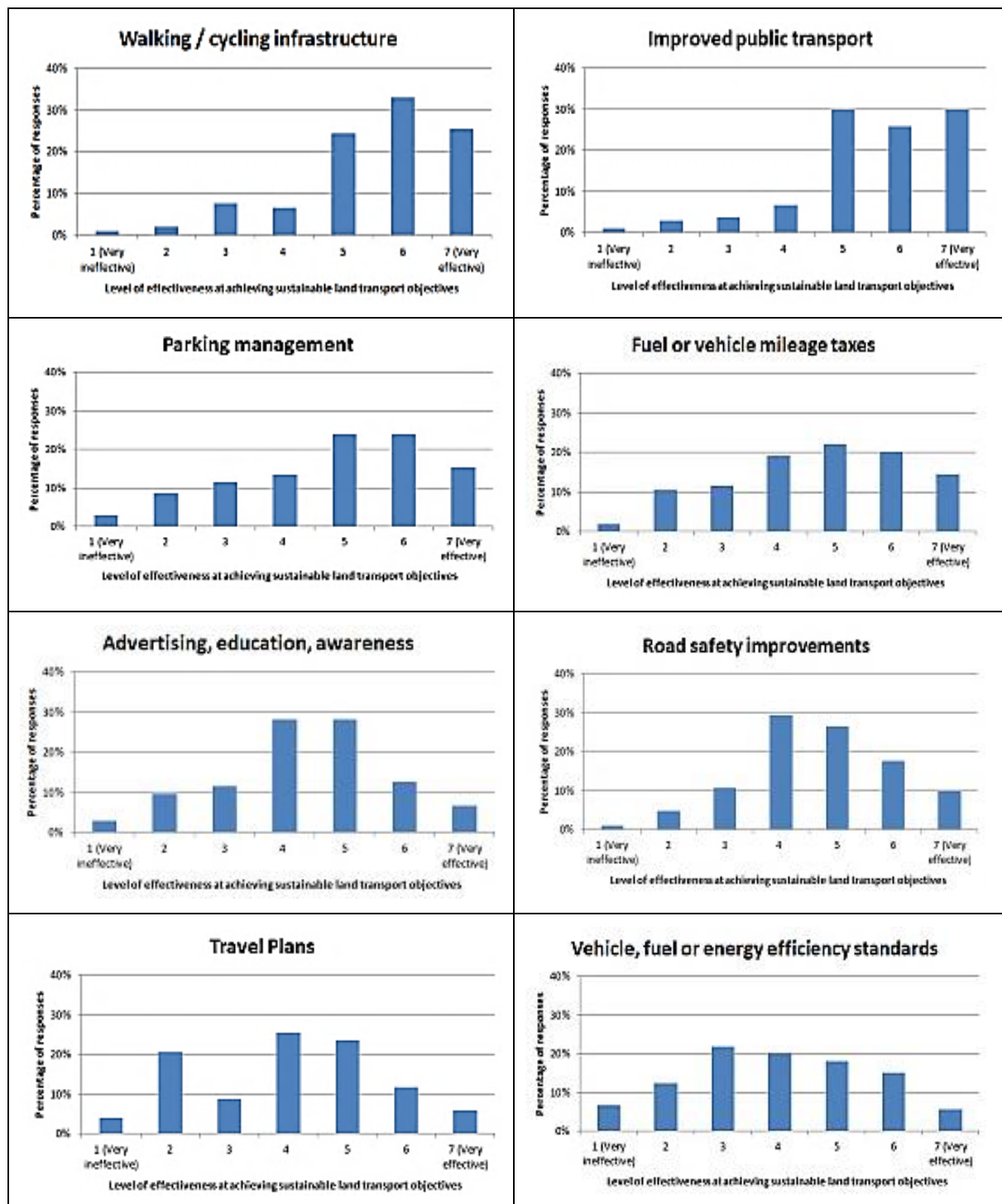
Please add any overall comments on reducing urban speeds

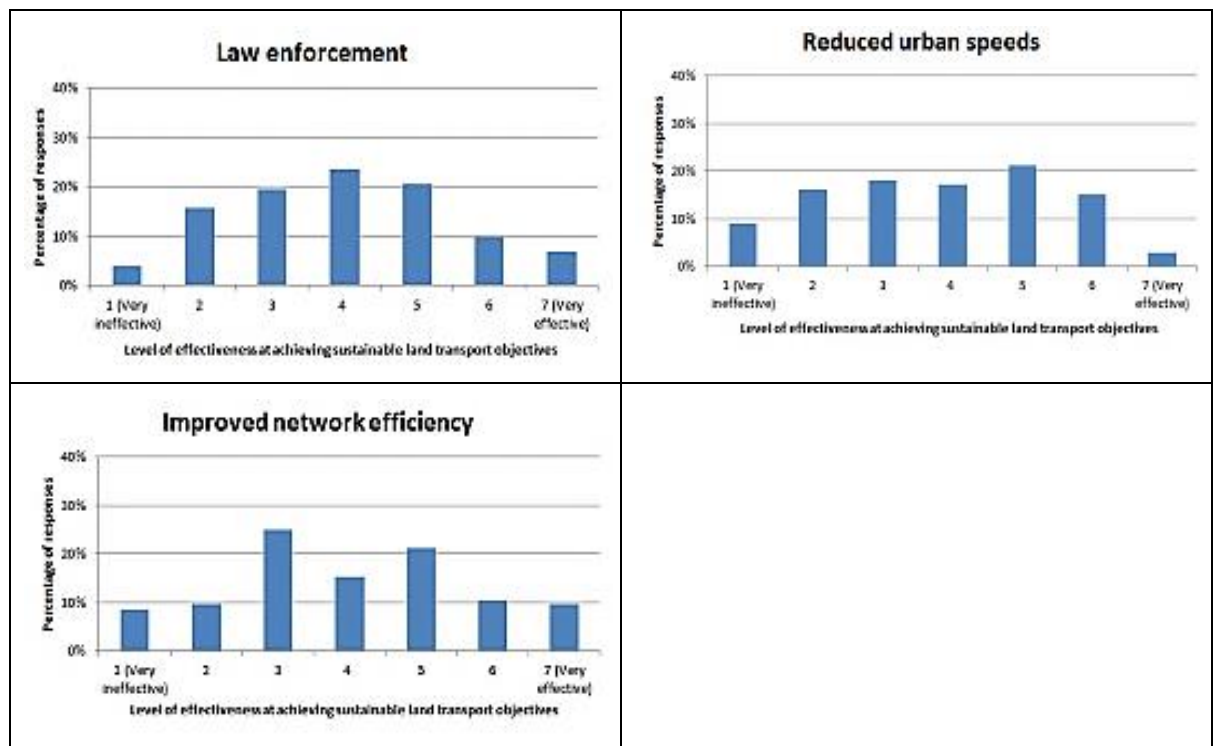
10. Thank you for taking the time to complete this survey

If you wish to be entered in the prize draw to win a \$50 Whitcoulls voucher drawn at the completion of this survey please enter your contact details below. The prize winner will be randomly selected.

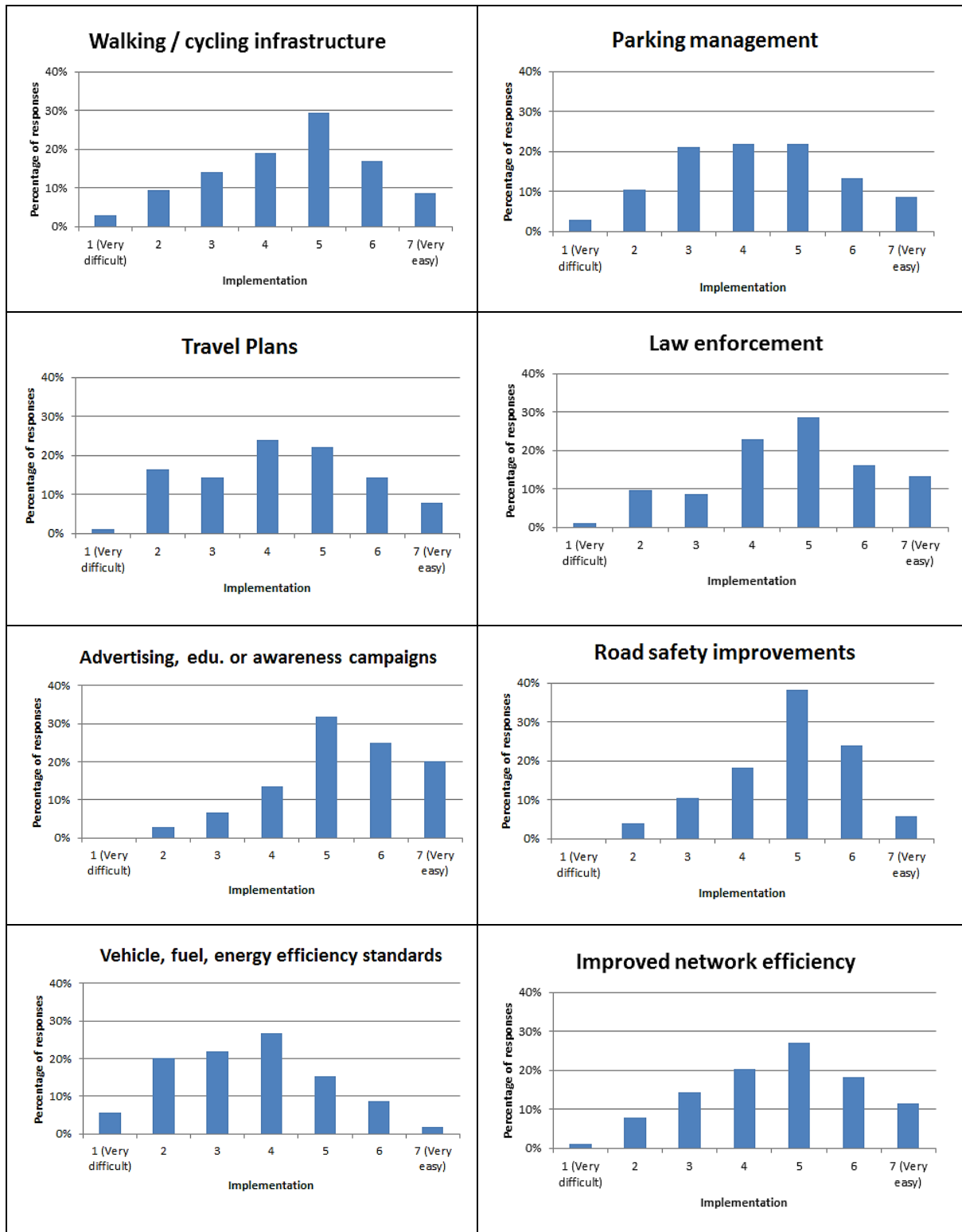
Provision of your contact details is optional and only required if you wish to be entered into the prize draw. Please note that these will be separated from your survey responses and you will not be publicly identified as the prize winner.

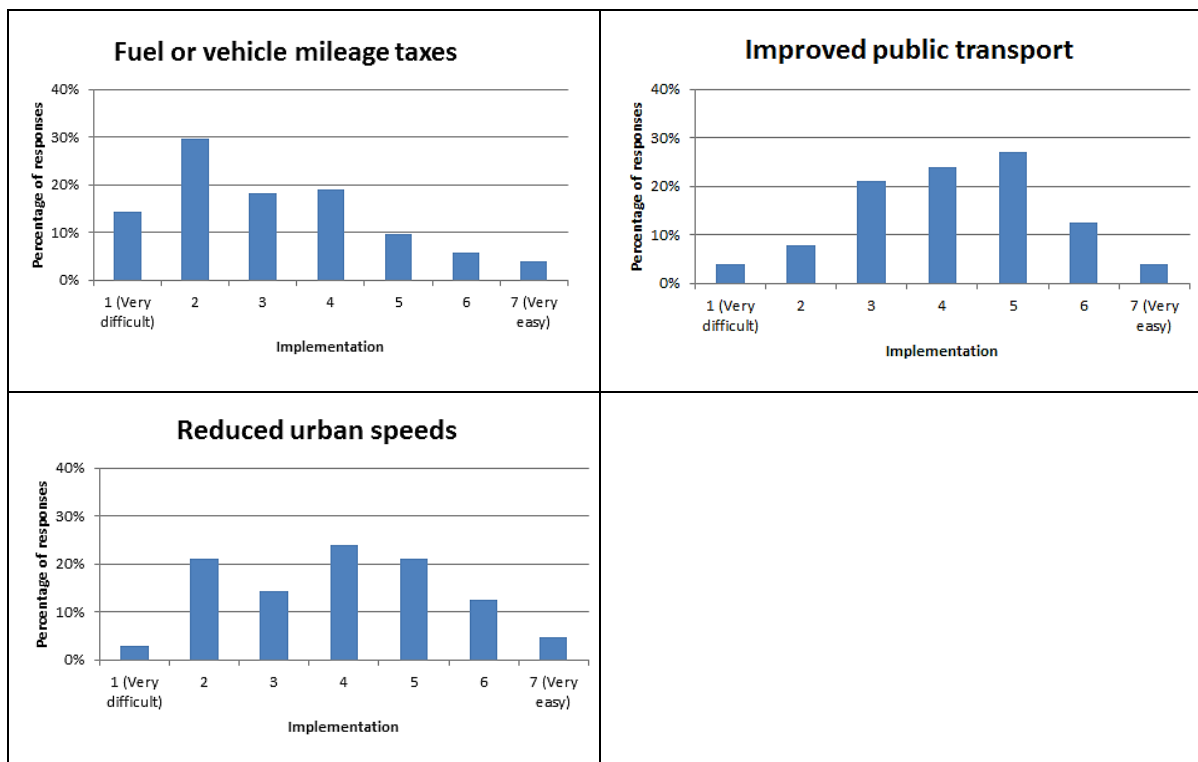
Appendix 4: Survey Results, Question 4



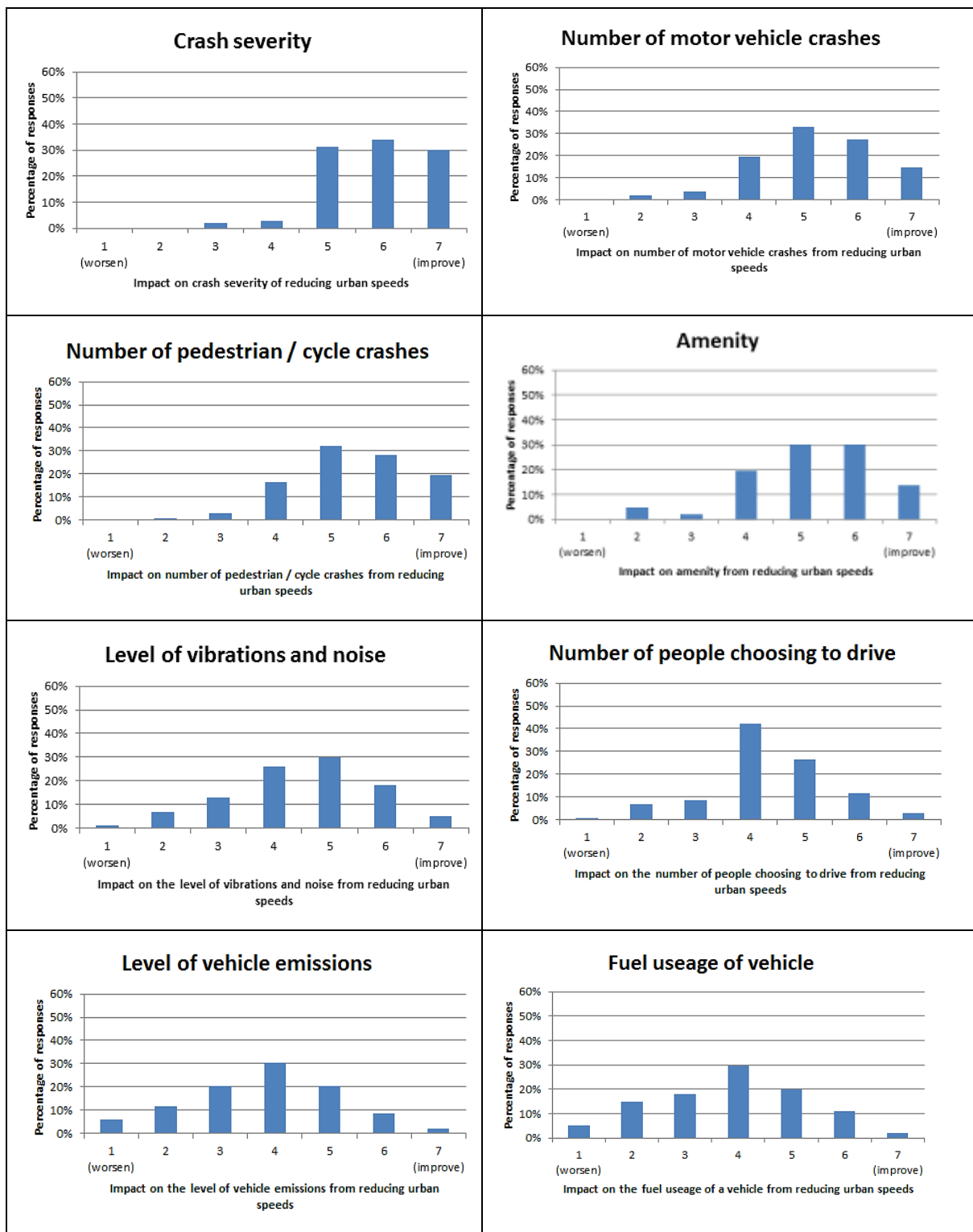


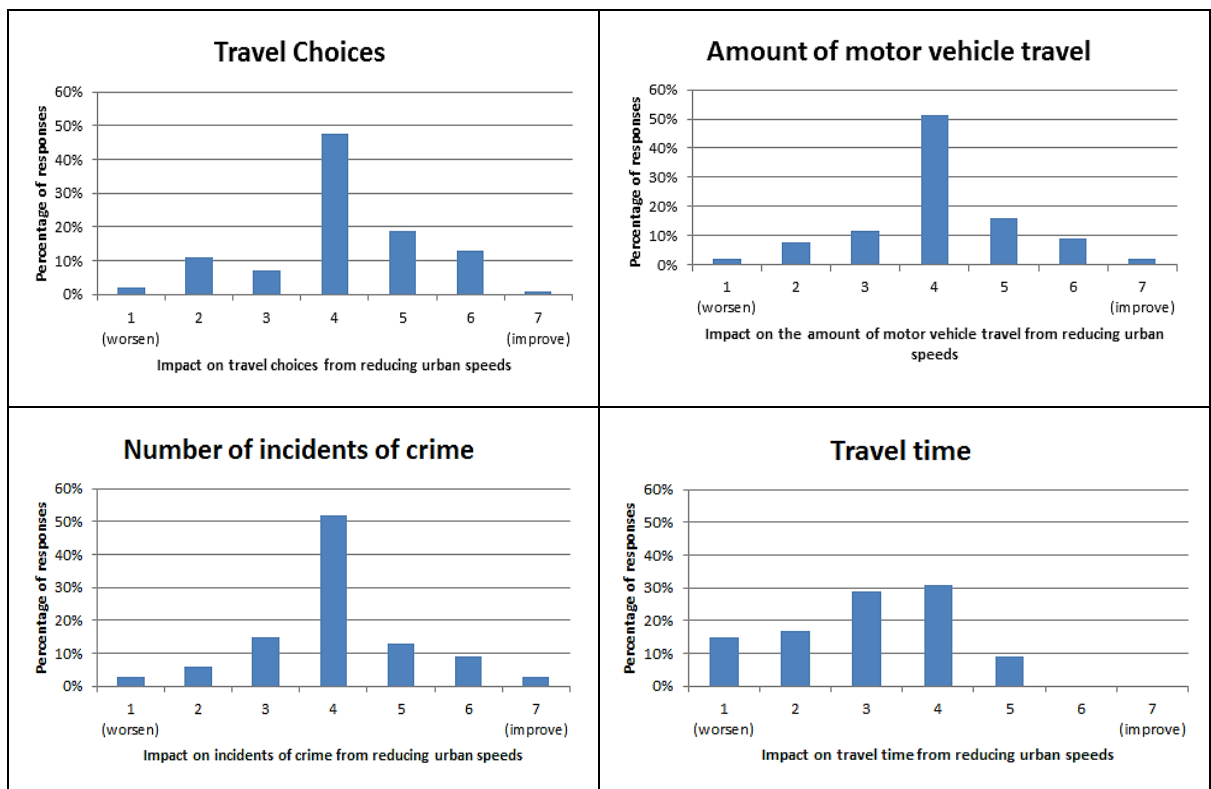
Appendix 5: Survey Results, Question 5





Appendix 6: Survey Results, Question 6





Appendix 7: Survey Results, Question 7

